THE TELEGRAPHIC JOURNAL.

Vol. I.—No. 2.

GOVERNMENT CONTROL OF TELEGRAPHS. — OPERATORS' SALARIES.

Perhaps of all the Governmental departments the Post-Office is the one which renders the public the most obviously beneficial services. A thinker of very unsophisticated mind might possibly conceive a happy life independent of the Record Office, the Ecclesiastical Commission, or the Admiralty, and he might even go so far as to consider the existence of the Customs not "involved in the idea of" general comfort. But once do away with the Post-Office, putting no substitute in its place, and the deprivation would tell on nearly all of us. We are now so accustomed to it that we can scarcely picture what would ensue if all its *employés* had a week's holiday, and St. Martin's-le-Grand were locked up. It is, indeed, an exceptional branch of the Civil Service, inasmuch as it is so intensely wrapped up with our daily life and personal convenience.

Now if, from the point of view taken by a typical unit of the public, the Post-Office is the most vital branch of the Civil Service, the Telegraphic Department is the most vital branch of the Post-Office. Already it is nearly as much in use as the older part of the Post-Office, and to many its efficiency or non-efficiency is at times considerably more important than that of the letter-carrying business. Having been at first a wonderful luxury, it is fast growing to be an imperative necessity. Indispensable as the new apparatus has become, however, if we would maintain anything like the proper standard of efficiency our electric medium of correspondence must necessarily retain some of its old and purely luxurious attributes. But all luxuries must be paid for; and if the electric telegraph is a luxury, and one which we covet, why we must be willing to pay for it. Nothing is so detestable as a "cheap and nasty" luxury. What, then, is the proper standard of efficiency for the telegraph? We want accuracy, speed, and confidence as to privacy, to make it what it ought to be. We are not going now to discuss how far the telegraph, in its present state, falls short of that standard in all three respects; let us fix our attention on the last point—that of confidence as to privacy.

Not long since we heard of a telegraph clerk who was detected in disclosing a piece of sporting news which passed through his hands. It appears he had been bribed into doing it, and the consequence was that he was sentenced to six months imprisonment. He was a young married man, 23 years of age, was receiving 21s. a week, and had been 12 years in the service. So it seems to be the old story of poor pay, family necessities, and strong temptation.

Nor is it very difficult to apply the moral contained in these facts. Setting aside considerations of humanity, and consulting mere expediency, we have a right to get anything done as cheaply as possible; but "doing it" includes, as a necessary condition, doing it properly, and according to certain rules imposed. If the Government can obtain young men who will be both honest and efficient telegraph clerks at 21s. per week, nobody need complain. But if the Government, proceeding on some abstract rule, limits the pay to a fixed small amount, and deliberately runs a risk of getting the wrong sort of man, the suffering public has an excellent right to complain loudly. We have all grown familiar with the conventional programme of the criminal clerk. We may have satisfactory references as to a young man's good character. He is engaged as a clerk. He is underpaid. He is expected to be as true as steel. He has a strong temptation. He yields, violates his duty, and is detected. In his defence, evidence is adduced showing "previous good character," &c. Sentenced and imprisoned, we hear no more of him. Now either his character was more "previous" than "good," or he is no worse a fellow after the commission of the crime than he was before; either he was naturally vicious, and the system failed to detect his vice, or, his testimonials having been fairly truthful, he was thrown amid circumstances of combined poverty and temptation which were too powerful even for a well-intentioned man. There is no advantage whatever in setting traps for consciences. If we succeed in catching them it is at our own expense, and when caught they are only fit for transportation. The criminal clerk may be detected and punished, but the offence is committed, and its commission has entailed all the harm we desire to avoid.

The case before us might appear to argue the expediency of raising the salaries of the *employés* in the Telegraphic Department, unless we are prepared to waive many of the best advantages which we have been taught to expect from the service. If we are not willing to pay more, we must let the telegraph perform humbler functions, and henceforth only send messages that any one might be allowed to see, no longer trusting the more confidential communications in their hands. This would be a great loss, certainly; but what is to be done if the price of honesty is considered too much to pay? There is, however, a third course to adopt; it is, to re-arrange the salaries, without actually increasing the aggregate amount. There can be little doubt that there are youths, or even young men, of the class from which the present clerks are drawn, whose friends and connections would be at least as glad as they are now to secure for them places in the public offices, even at a rate of pay decidedly lower than that usually given in the earlier years, if there were a prospect of a steady increase in the future. On the other hand, put in a position with an immediate command of less pocket-money, the young man himself would feel a great dependence upon the protectors of his youth, and would be compelled a little more to study his outlay. Thus he would be trained into habits of economy, while looking forward to that later period at which he could more reasonably hope to have a home of his own, with its natural liabilities. Again, if some few posts at the head of the ordinary list were endowed with yet higher pay, they would stand out as prizes to attract all the more intelligent and steady men of the department; and while they were thus encouraging the development of the best qualities in the whole class, the gain to the successful few, from time to time, would make them living examples for their fellow-workmen. In short, if the maximum income were more, though the minimum income might be less, the average remaining the same as at present, there would at once be vastly increased inducements to honesty, steadiness, and zeal. The telegraph clerk's financial affairs would not then get bad "by degrees and beautifully" worse. His happiest years would not then be his boyhood with ample pocket-money, to be succeeded by a married manhood struggling with poverty.

GENERAL EARDLEY-WILMOT ON TELEGRAPHY.

General Wilmot, in his Address to the Society of Arts for this year, says—"Had the conclusions enunciated in the discussions of the Society on the expediency of the adoption of telegraphic communication as part of the postal system of the country been acted upon when attention was claimed and due for examination and action, an immense sum of money would have been saved to the public, who might by this time have had the advantage of sixpenny telegraphic rates, such as those long enjoyed, with immense advantage to Arts, Manufactures, and Commerce, in Switzerland, Belgium, and Germany. The same conclusions had, it appears, been formularised and presented for attention within the department itself, but without effect. Now, every year's inattention and delay may be said to have cost the public not less than half a million of money, until the adoption of the principles in question, as respects the inland telegraphs. The identical principles are applicable to the ocean telegraphs, and it is to be represented that there is a similar large cost accruing during the delay of the adoption of those same principles, an adoption which, if we are to keep pace with Continental states, may be declared inevitable. It will be remembered that it was represented that the Government could do what trading companies could not do; that the Government could utilise numerous existing postal offices, and an immense postal service; that the Government could make extensions of stations with a profit, or at the cost of the service, which the trading companies could not do without loss: that the Government might make reductions of tariffs, and sustain temporary reductions of income, which could not be done by trading companies; that the Government, by unity of management, as well as by utilising existing establishments, could effect savings which might be divided between the public and the shareholders. All this, which was done in respect to the inland telegraphs, is incontestably applicable to the ocean telegraphs. They were, indeed, comprehended in the original scheme, but were left out for want of time. It is to be borne in mind that the saving of time by the inland telegraphs is of hours and days, but by the ocean telegraph of weeks and months; and social messages being comparatively few, or of no account, in ocean telegraphy, it may be set down that, as a rule, every telegram moves at least one transaction in manufactures and commerce, and that this new power of movement is applicable to upwards of six hundred millions annually of imports and exports. The chambers of commerce will appreciate—have, for the most part, appreciated—the importance of the movement undertaken by the Society." Those who know the energy with which the Society of Arts carry out their projects, or have witnessed the disinterested beneficence of their labours, will, especially if connected with commerce, lament this case of "what might have been!" Let us hope the "is to be" not far distant.

Milde's Marine Watch.—A new and useful application of electricity has just been developed by MM. Mildé and Co., of 5, Rue Bizet, Paris, whose electric clocks, it will be remembered, formed a prominent and interesting series of exhibits in the French Annexe at the late International Exhibition at South Kensington. M. Ch. Mildé has designed an electric marine chronometer for ships, which will possess many advantages over the ordinary chronometers. This apparatus will require no winding up, and will be unaffected by variations of temperature or the shock or motion of the vessel, or any other causes of perturbation; and can be arranged to indicate, by simple means, the true time in all parts of the vessel.

An American sea captain writes to suggest telegraphic communication with lighthouses, in order to regulate the exhibition of storm-signals, which he proposes to display on these buildings.

OHM'S LAW AND KIRCHHOFF'S COROLLARIES.

THE following note, showing the simplest way in which Ohm's law of galvanic circuits and the two corollaries of this law (commonly known as Kirchhoff's laws) may be mathematically deduced, is extracted from the proof pages of a new edition of the author's work now in the press.

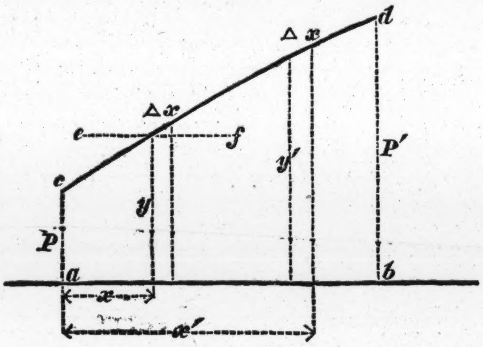
I. OHM'S LAW.

The current is directly proportional to the electromotive force, and reciprocally to the resistance, in a circuit of dynamic electricity.

This is the simplest expression of the electrical relation known as Ohm's law, and its truth may be proved as follows:—

In the conductor (Fig. 1) let the point a be connected with a constant source of electricity whose potential is P; and let a second point, b, of the same conductor be connected with a constant source whose potential has some other value, say P′; and let the line $c\ d$ represent the curve of the tension at each point along the conductor, or the electric "fall;" that is to say, that ordinates raised from $a\ b$ to $c\ d$ give the potentials of the points upon which they are raised. At a distance, x, from a, let the potential be y, and at an infinitely small distance, Δx, further on, let it be $y+\Delta y$. That very small portion of the curve, $c\ d$, which lies between these two neighbouring verticals, we may regard as a straight line, forming an angle, α, with $e\ f$; so that—

FIG. 1.



$$\frac{\Delta y}{\Delta x}=\tan\alpha \quad . \ . \ . \ . \ . \ . \ . \ . \ (1.$$

When $\frac{\Delta y}{\Delta x}=1$, let the quantity of electricity which flows, in the unit of time, through the unit of section of the conductor, or its conducting power, be k. Then if the section of our conductor be s, the quantity of electricity, k', which flows through the short length Δx in an unit of time will be—

$$k'=k\,s\frac{\Delta y}{\Delta x} \quad . \ . \ . \ . \ . \ . \ . \ . \ (2.$$

Again, take another point at a distance, x', from a, where the potential is y'; and at the short distance, Δx as before, further on, it is $y'+\Delta y'$; so that—

$$\frac{\Delta y'}{\Delta x}=\tan\alpha',$$

the quantity of electricity flowing in each unit of time through this short length will be—

$$k''=k\,s\frac{\Delta y'}{\Delta x}.$$

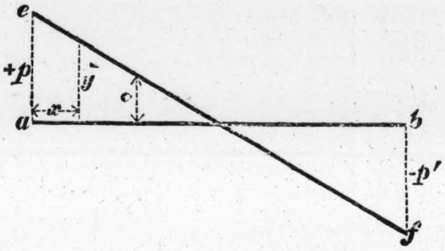
It is, however, obvious that, so long as the sources P and P′ are constant and flowing one into the other, the quantity passing in the same time, any given two points must be equal; that $k'=k''$; and therefore that—

$$\frac{\Delta y}{\Delta x}=\frac{\Delta y'}{\Delta x} \quad . \ . \ . \ . \ . \ . \ . \ . \ (3.$$

It follows that $c\ d$ is a straight line. The *steepness* of this line represents what Ohm calls the "*electric fall.*"

Make it straight, as in Fig. 2. Then the ordinates on $a\ b$ will express the tension at every point of the conductor, corresponding to the given end tensions p and $-p'$, say of the two poles of a galvanic element, for instance. In order now to determine the tension y of a point distant, x, from the end a, let the angle made by $e\ f$ with $a\ b$ be $\alpha°$. Then—

FIG. 2.



$$\frac{p-y}{x}=\tan\alpha.$$

$$y=p-x\,.\,\tan\alpha \quad . \ . \ . \ . \ . \ . \ . \ . \ (4.$$

The length of the conductor being l, if $x=l$ it is obvious that $y=-p'$,

$$-p'=p-l\tan\alpha.$$

$p+p'=\mathrm{E}$, the electro-motive force of the circuit, therefore—

$$\tan\alpha=\frac{p+p'}{l}=\frac{\mathrm{E}}{l};$$

and putting this value in (4, we get—

$$y=p-x\,.\,\frac{\mathrm{E}}{l};$$

or—

$$p-y=\frac{\mathrm{E}}{l}\,.\,x.$$

It follows from this that *the electric "fall" from* P *to* Y *corresponding to any given length,* X, *of a homogeneous conductor, is directly proportional to the difference between the potentials of the poles, or to the electro-motive force of the system, and reciprocally proportional to the length of the conductor.*

Similarly we have, from any other point, x' having a tension y',—

$$p-y'=\frac{\mathrm{E}}{l}x',$$

whence—

$$\frac{y-y'}{x'-x}=\frac{\mathrm{E}}{l} \quad , \ . \ . \ . \ . \ . \ . \ (5.$$

Putting this value of $\frac{y-y'}{x'-x}$ instead of $\frac{\Delta y}{\Delta x}$ in equation (2, we find the quantity of electricity flowing through the circuit in a unit of time to be—

$$k'=k\,s\,.\,\frac{\mathrm{E}}{l},$$

or—

$$k'=\frac{E}{\frac{l}{k\,s}} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (6,$$

of which $\frac{l}{k\,s}=r$, the resistance[*] of the circuit.

Therefore *the current, or the quantity of electricity flowing through the circuit in a unit of time, is directly proportional to the electro-motive force, and inversely to the resistance.*

The simplest algebraical expression of this law is—

$$I=\frac{E}{R}.$$

I being the current, or quantity of electricity flowing per second through the circuit, E the electro-motive force, and R the resistance.

Ohm's law regards the galvanic current traversing simple closed circuits only. Problems often occur in practice, however, in which it is necessary to consider the circuit as made up of several branches, or what are called " derived " or " shunt " circuits.

II. Kirchhoff's Laws.

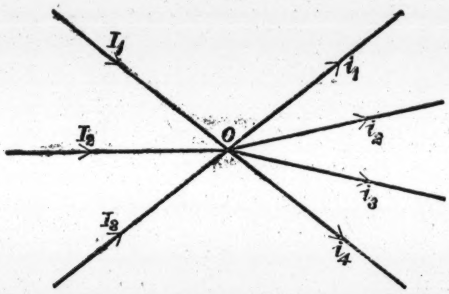
For this purpose Kirchhoff[†] has provided two corollaries, which he has proved experimentally, and established on the basis of Ohm's fundamental law.

Kirchhoff's first law is that—

" *The sum of the currents in all those wires which meet in a point is equal to nothing.*"

Let O (Fig. 3) be a point in which seven wires meet; the currents I_1, I_2, and I_3 approach, and i_1, i_2, i_3, and i_4 recede from it. If we give the plus sign to those currents which approach and the negative to those which recede from the point, then the sum of all the currents is—

Fig. 3.



$$I_1+I_2+I_3-i_1-i_2-i_3-i_4=O.$$

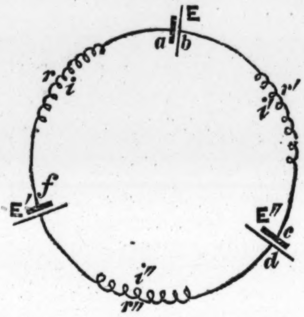
In other words, the sum of those currents which approach the point is equal to the sum of those which recede from it. The truth of this proposition is evident, for otherwise the point must be a reservoir of electricity, which is contrary to all our observations of the behaviour of dynamic electricity.

Kirchhoff's second law is that—

" *The sum of all the products of the currents and resistances, in all the wires which form an enclosed figure, is equal to the sum of all the electro-motive forces in the same circuit.*

In proof of this, let three elements, whose electro-motive forces are E, E', and E'', be connected in a closed circuit by the three conductors, whose resistances are r, r', and r''. Let the potentials at the two extreme ends of the conductor r be a and f, the potentials at the ends of r' be b and c, and the potentials at the ends of r'' be d and e, and, lastly, let the strength of the currents in r, r', and r'', be respectively i, i', and i'', as is shown in the figure.

Fig. 4.



The current-strengths in the three conductors are—

$$i=\frac{a-f}{r} \text{ or } i\,r=a-f,$$

$$i'=\frac{c-b}{r'} \text{ or } i'\,r'=c-b,$$

$$i''=\frac{e-d}{r''} \text{ or } i''\,r''=e-d.$$

And, by addition . . . . $\Sigma(i\,r)=a-f+c-b+e-d$;
or, that which is the same thing,

$$\Sigma(i\,r)=(a-b)+(c-d)+(e-f).$$

But the electro-motive forces being equal to the difference of potentials at the two poles of each element, we have—

$$E\;=a-b,$$
$$E''=c-d,$$
$$E'\;=e-f.$$

Therefore, substituting these values,

$$\Sigma(i\,r)=E+E'+E'';$$

Or,

$$\Sigma(i\,r)=\Sigma(E).$$

On Ohm's law and Kirchhoff's corollaries is based the solution of all problems which arise in dealing with galvanic circuits.

In a future number of this Journal we shall give some instances of its application to the solution of rather complicated problems.

Robert Sabine.

The *Panama Star* states that Bogota is now in telegraphic connection with the following cities of the United States of Columbia, viz. :—Ambalema, Hondo, Guaduas, Villeta, Facatativa, La Mesa, Ibajue, Cartago, Palmira, Tulua, Buga, Cali, Manozalez, and Medellin. The line to the north is being pushed ahead as far as Chiquinquira, that towards the south will be extended to Popayan, and that to the west as far as Buenaventura.

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[*] So far as the accuracy of our present measuring instruments allows us to investigate experimentally the relations between electrical magnitudes, it is found that the resistance of a uniform homogeneous wire is directly proportional to its length, and inversely to its sectional area. The causes which might operate to throw uncertainty upon this relation are too remote to affect any results which our mechanical contrivances will probably ever enable us to attain. It is, however, open to future investigation to determine whether the resistance of a circuit is not to some extent dependent upon the current flowing through it; that is to say, whether that body which offers a unit of resistance to one cell offers neither more nor less than a unit of resistance to a hundred cells.

[†] Kirchhoff, Pog. Ann., vol. lxiv., p. 512 (1845); vol. lxxii., p. 497; vol. lxxv., p. 189.

THE
WHEATSTONE AUTOMATIC TELEGRAPH SYSTEM.

Few inventors are so prolific as he to whom we owe our English system of telegraphy. Acoustics, light, and heat bear their imprint of the hand that has drawn together the elements of electricity into the serviceable form of the telegraph. But this month we are concerned with one only of the numerous telegraphic inventions of Sir Charles Wheatstone—his automatic system.

The system needs little description; it is too well known to the electrician; and to the general public the description that could be given in a short article could be by no means exhaustive. Yet a certain detail is necessary to our purpose; for we wish all our readers to form an independent judgment with regard to one or two statements by writers or speakers on the subject which we think to be erroneous.

We wish to recognise, clearly and fully, the value of the paper read at a meeting of the Society of Telegraph Engineers, by Mr. Culley, and entitled "Automatic Telegraphs." To this paper we are indebted for some of the facts we present to our readers,—facts that could not be obtained from any other source than the office of the Central Station of the Postal Telegraph Service, to which service it is well known Mr. Culley is Engineer-in-Chief. At the same meeting of the Society of Telegraph Engineers a discussion ensued, in which the advantages and disadvantages of the Wheatstone automatic system were fairly treated, as far as they were correctly stated. How correct we will consider presently.

Automatic instruments have been devised for telegraphy for the same reasons as have influenced the introduction of machinery, viz., speed, and—with speed—accuracy. The characters or symbols used in telegraphy are composed—as those acquainted with the subject are aware—of two elements, a dot and a dash. But we all know what would be the consequence of writing or printing our words without spaces; and, similarly, telegraphic symbols without spaces would be incomprehensible. The remark is common in a telegraph office—"What a bad sender; no spaces!" Spaces, then, are as distinctly an element of good telegraphic writing as are the dots and dashes; so that, in strictness, we ought to include in the symbolism three elements instead of two. Automatic instruments, then, give superior finish to the workmanship of each of these three elements. Hence the advantage of the automatic system; for machinery, and not nerves and flesh, being in question, the limit of cohesion between ink and paper is very nearly the limit of speed. A hundred and twenty words per minute have been attained between London and Liverpool, Manchester, and Cardiff; a rapid speaker cannot get through his work much more quickly.

The symbols are "received" upon a long paper ribbon, upon which they are impressed by a small inking-wheel; they are "transmitted" or "sent" by means of another paper ribbon, perforated with holes corresponding to the dots and the dashes imprinted by the receiving instrument; so that *the limit of the speed of the transmitter is the rate at which the perforated ribbon can be passed between the rollers of the transmitting instrument.* Fig. 5 shows the word "send" as it appears on the slip of the *receiving* instrument; Fig. 6 shows the same word in the perforated ribbon of the *transmitting* instrument.

Fig. 5.

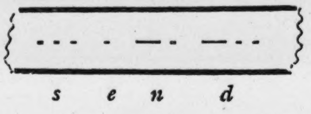
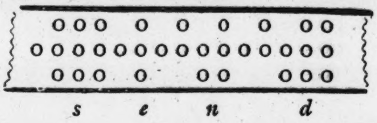
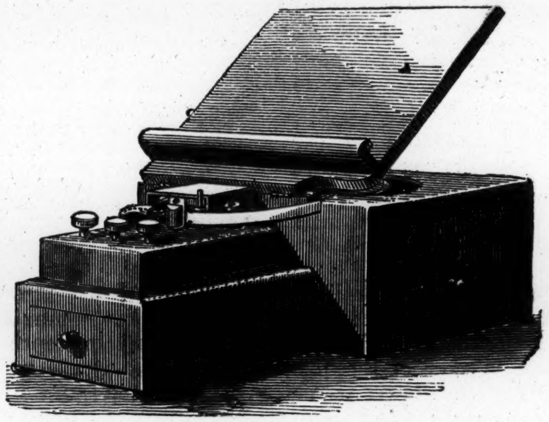


Fig. 6.



The perforations are made by an instrument—the perforator,—a form of which is shown in Fig. 7. This instrument, being purely mechanical, it is unnecessary to describe.

Fig. 7.



The Transmitter.—This instrument is shown in Fig. 8; the principal portion of the mechanism is Fig. 9.

R, Fig. 9, is an ebonite rocking beam, moved by wheel-work and carrying three pins. The left-hand pin is connected to line, the pin to the extreme right to earth, while the centre pin is insulated. This insulated pin makes contact with the curved lever, B, and one of the battery levers, C or Z, according to the position of the rocker, R. Beneath the rocker are two levers, A and B, connected electrically by means of the springs, H H′; these levers carry each a vertical needle, V V′. These needles determine the nature of the current sent to line, and they are directed by means of the perforated paper-ribbon, L, and the grooved wheel, W. They are alternately presented to the surface of the paper-ribbon, through which, if there should be a hole, one of the needles passes, and the pins on the rocker making contact with one or other of the levers the current is sent to line; but should the surface of the paper be entire the needle V cannot rise, the lever A is kept depressed, the contact is broken with the line-pin on the rocker, and no current passes to line. By this system of contacts a far higher rate of transmission can be attained than would be possible were the paper passed between two metallic surfaces simply making contact between themselves; and there is the further advantage that all contact-points are under glass protectors from dust and oxidation.

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* We are indebted to Sir Charles Wheatstone for these Illustrations.

The result of this arrangement is to give a succession of "equal currents of opposite signs," and thus to secure higher speed. If we now study the paper slip, we shall see that when a pin enters a hole in the upper side of a perforated slip, a current is produced in the direction necessary to depress the marker of the printer; and when it enters a hole in the lower side a current is determined in the opposite direction, and the blanks are formed. The duration of the mark or interval depends on the time allowed before the current is inverted. When the two holes are in the same vertical line the inversion follows immediately, and a dot is formed; when they are in adjacent vertical lines it follows after two intermissions, and a dash is formed.

FIG. 8.

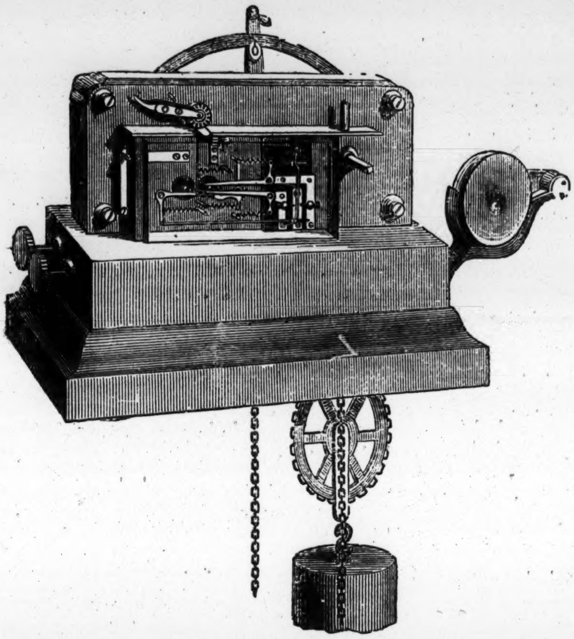
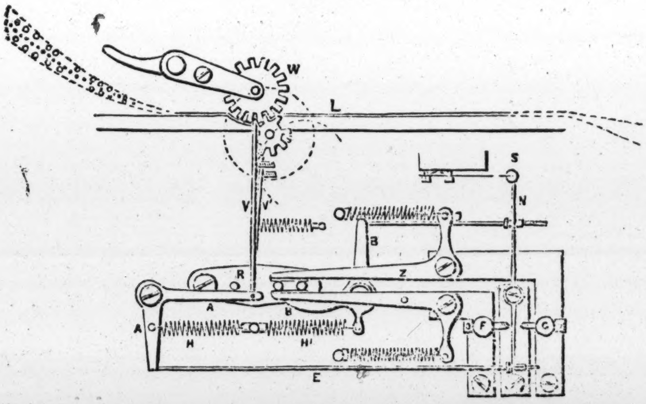


FIG. 9.



The Recorder or Printer.—This instrument is shown in Fig. 10.

The armature of this apparatus is so arranged that the printing-disc remains in contact with the paper until a reversing current arrives; it has, in fact, no spring, and remains where left by the last current. The method of adjusting the resistance of the needles between the two electro-magnets is shown in Fig. 11. R is the printing-disc, attached to an arm jutting from the axis of the printing-magnets, M M; R' the ink-wheel; K the ink-well; A A' the paper-rollers; P P' the paper-ribbon; T T' the micrometer screw acting on the wheel M, by which the tension of the chain S is regulated. By means of this adjustment the opposite current may be made to act on the needles equally, or in any unequal proportion that may be found to produce the best effect. If the action depressing the marker be too strong, the lines will run on; on the contrary, if the action raising it be too strong, the lines will fail.

FIG. 10.

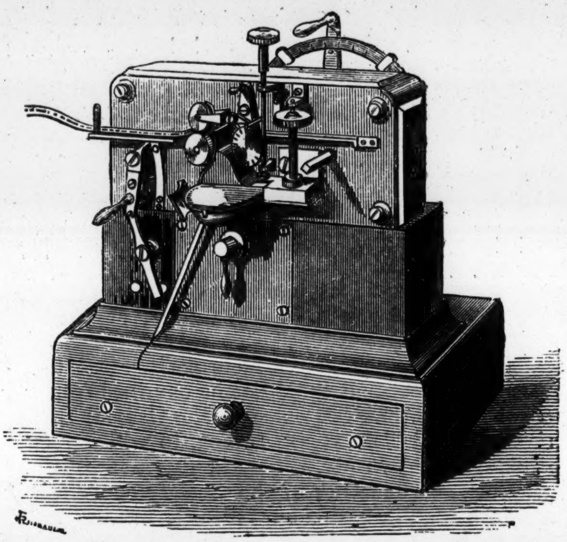


Fig. 12 shows the relay worked upon the induction-current system. R R' are the coils of the electro-magnets; *a c a* the contacts; B the battery, divided into two parts to form the local or the line circuit. The current to be transmitted enters by *w w'*, completes the local and primary circuit, *b b'*, of the induction-coil, I, the secondary current from which proceeds to line.

The objection to which we have referred has been stated as follows:—"The act of punching, the act of preparing the message, and the various processes it had to go through before it passed through the transmitter, involved delay, and the result was that the messages transmitted by these means invariably incurred delay; trifling when taken in the aggregate, but which could not be admitted in short circuits.

The "act of punching" is the "act of preparing the message," and includes the "various processes." There must be some error in the authority for the statement. The message perforated at the rate of 40 words per minute in the paper slip is at once ready to be passed through the transmitter at the rate of 120 words per minute, so that one transmitter may be fed by three or four clerks. We really fail to see the cause of the delay as far as concerns the instrument.

The subject is one of great importance, but our space forbids our entering more into detail now; we intend, however, shortly to explain more fully the practical working of this and other automatic systems.

FIG. 11.

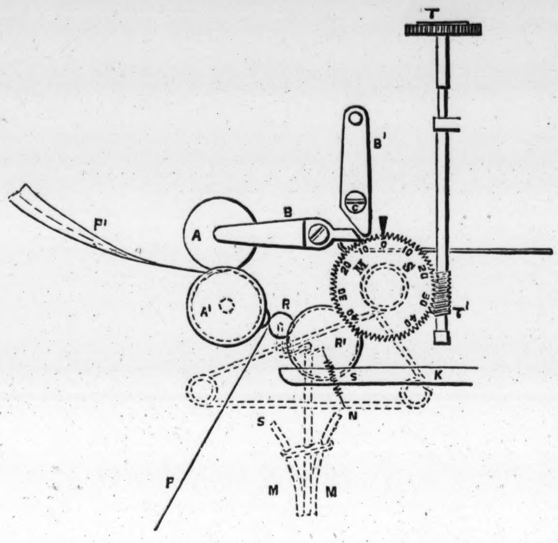
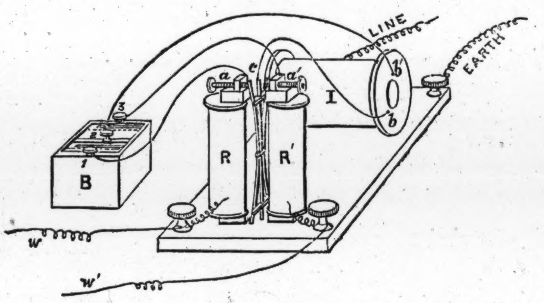


FIG. 12.



SOME PHENOMENA PRODUCED BY LIGHTNING.

By FATHER SECCHI.

EIGHT years ago some lightning conductors had been erected under my direction on the cathedral and on the Bishop's palace of Alatri, situated at the summit of the Acropolis of that town, which, by its elevated and solitary position, was exposed to frequent ravages from storms. It was not long ago that a flash of lightning demolished a great part of the belfry, and damaged the organ of the church. In the erection of this lightning conductor there arose a great difficulty proceeding from the nature of the soil, which at the depth of some centimetres turns out to be entirely of solid calcareous rock.

In order to remedy this defect, that part of the conductor which enters the ground has been made very long, more than 4 metres, and has been provided with a great many couples of points, 5 centimetres broad, 5 millimetres thick, indentated on the edges, with the addition of a thick copper wire twisted among the same points, to help to multiply the points of contact between the rod and the carbon. The foot of the lightning conductor is entirely of copper; the rod is also of copper up to a metre above the ground, and there it is joined to the iron conductor in the ordinary receptacle made in the heart of the wall to preserve it from disturbances at the inferior parts. The ditch, into which the foot of the lightning conductor has been sunk, is 5 metres long, 0·60 metre wide, and it was dug until it came upon the roots of some neighbouring trees; a layer of cinders was then placed to a height of 20 centimetres, which extended over the whole lower surface of the ditch. Thus the surface of contact between the metal and the carbon and of the latter with the soil, was such that one would suppose it to be more than sufficient, and the presence of trees, although they were not large, raised the hope that there would be always enough moisture. Moreover, as the edifice had two culminating points, viz., the belfry, and the hinder portion of the choir, two rods were placed with points and feet, and the two rods have been joined together on the roof by a conductor, so that, in the case of a discharge on one of the points, the lightning would find two ways for spreading itself in the soil.

These precautions have produced a happy result, since in this interval the tower having been struck at least four times, the edifice has sustained no damage, not even in the last case, although, as we shall see, the discharge had been appalling.

This flash of lightning took place in the night of the 2nd of November, during a furious storm, in which there had been flashes and peals of thunder for two hours. The belfry was struck at first by weak discharges twice, but the third time the discharge terrified the whole town below. Fortunately everything was preserved, excepting that small injuries were made by the discharge on the outside of the building, and which I am now going to describe.

I should state first that four years after the erection of the lightning conductor the conducting-pipe of drinkable water for the towns of Alatri and Ferentino was completed, and that the water-works were built near the belfry at a distance of some metres from the lightning conductor. The conductor was not placed in communication with the water-pipe, because previous observation had shown that it acted well, and that the presence of the water-works and of a neighbouring fountain imparted much moisture to the plot of ground into which the conductor was sunk. I was not asked if it was necessary to establish this communication, and if I had been asked I should perhaps have regarded it as superfluous. It is as well to say that three cast-iron pipes empty themselves into these water-works; one has a diameter of 15 centimetres, and is 15 kilometres in length, which comes from the fountain; the other is 18 centimetres in diameter and 12 kilometres long, and goes to Ferentino. These tubes are side by side, and touch one another at several points in the water-works. The water was not plentiful, but it circulated in all the tubes.

It nevertheless happened that in the night mentioned above, at the third enormous charge the lightning passed from the foot of the lightning conductor of the tower to the tube of Ferentino and to that of Alatri, producing the following effects:—

1. It made in the earth a perfectly rectilinear ditch, which, from the lower extremity of the lightning conductor, went to the tube of Ferentino

in the water-works, and in traversing the wall destroyed the angle of that structure. The earth of the ditch thus dug was disposed regularly to right and left with great symmetry. The length of the ditch was about 10 metres, the depth about 70 centimetres.

2. The lightning struck the water-pipe of Ferentino, broke it completely, throwing the pieces to a distance of about 80 centimetres; the lead which soldered the join of the broken tube with the tube beyond was found melted. In consequence of this rupture the water ceased flowing to Ferentino, and poured into the water-works.

3. Another part of the discharge spread itself by the pipe which goes to Alatri, and traversing the reservoir threw to a great distance some wooden plugs which stopped up the discharging tubes, plugs forcibly hammered in; it arrived at the town in a tank, where it damaged and twisted in a strange manner a leaden slab which was in the tank, made some other little injuries, and finally left the trace of its passage at the spouts of the public fountain.

4. The point of the lightning conductor was examined, and it was found very blunt; it was found impossible to unscrew it, and it could not be removed without breaking the screw. It was found broken to a length of more than 3 centimetres, and the section of fusion is nearly flat, as though it had been cut; the diameter of the section is about 1 centimetre. The gold of the gilding had nearly all disappeared. In the church and in the edifice which is attached to it, no injury has been detected. These facts appear to me important both for practice and theory. For theory, because they give an idea of the quantity and of the immense force of the discharge. The melting of the point down to a section 1 centimetre in diameter proves that it would have been melted down much further if it had been slighter; it is not prudent, then, to use very slender points; it is best that they should thicken quickly.

The excavation of the ditch at the foot of the lightning conductor could not be the direct effect of electricity, but would be the result of the sudden evaporation of the moisture of the ground, generating steam, and forming, as it were, a mine.

The breaking of the tube is most singular. It seems to me that it can with difficulty be attributed to the mechanical shock of the electricity itself. As the lead which united the broken tube to the one beyond was found melted, it is evident that, in spite of the water which flowed in this tube, it was raised to an enormous temperature in the place where it was struck, and probably it was the instantaneous evaporation of the water inside which caused the breaking of the tube.

But the most singular fact, in a certain respect, is what was observed in the tube which descends to Alatri; that is to say, the alteration in form of the leaden slab. The little interruption which necessarily exists in this tank between the conducting-pipe and the metallic receptacle evidently gave occasion for a discharge by a flash, and in consequence for an explosion of steam. But we see at the same time by that that the distance traversed in the tube from the building to the slab, a distance of more than 200 metres, in which the pipe is buried underground, did not suffice for the charge to lose itself in the ground, although during the passage it had to cross the reservoir and might there have distributed itself. Our surprise is still greater when we reflect that it was only part of the discharge, since the greater portion had to flow by the water-pipe of Ferentino, which was the first struck in a direct manner, and that these pipes are joined together with lead. The quantity of electricity must have been enormous, in order to be able to have so much force and to run another 300 metres, to reach the public fountain, and leave its traces there. A circumstance which deserves attention is that this storm took place after a long and constant drought; and consequently the earth was less moist and could offer little facility for dispersion. These cases are not as rare among us as one might suppose. Not very long ago, at Lavinia, a flash of lightning destroyed a great part of the belfry, passed to the bell, broke and melted it in its passage, in such a manner that the metal had run away like wax. I do not believe this breakage of the bell to have been a mechanical effect of the lightning in a rigorous sense, for the bell could have been broken by the instantaneous expansion produced by the heat at the point of the passage, an expansion which had had no time to disperse, as a glass vase breaks when touched with a red-hot iron.

Let these facts come about how they may, they enable us to see that it is necessary to devote great attention in the erection of lightning conductors, that we must allow them a large surface for discharge, and that there can never be too much of it. The surface of the foot of our lightning conductor was certainly superior to what has been judged sufficient by Matteucci for the discharges of telegraphic conductors, and yet it has not sufficed. Further, it is a confirmation of the necessity of making the neighbouring metallic masses communicate, and especially with water-pipes or gas-pipes.—*Les Mondes.*

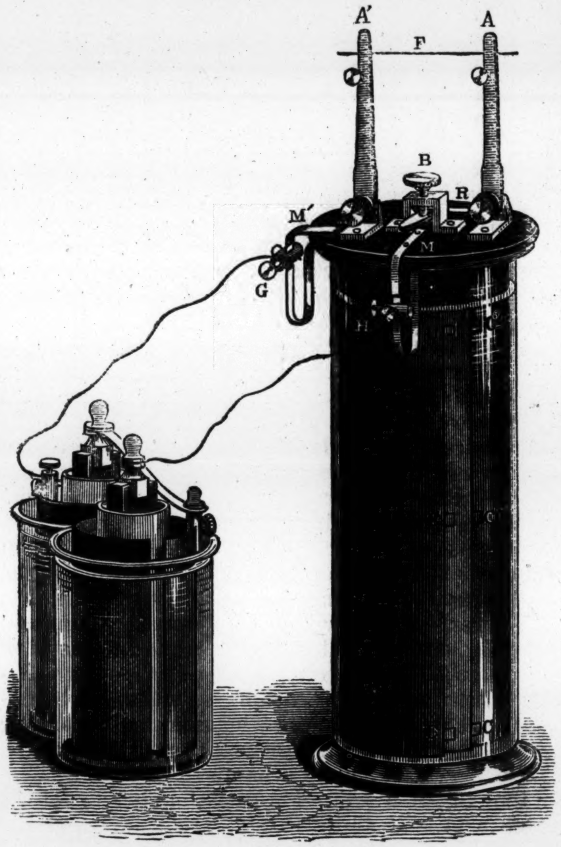
M. PLANTÉ'S SECONDARY BATTERY.

Ritter was the first to occupy the attention of the public with this kind of battery; Jacobi the first to make the application to telegraphy. The secondary battery at this stage of its progress consisted of a series of plates of platinum, plunged, two by two, in different compartments of a gutta-percha case, united to one another in such a manner as to obtain —by the intervention of acidulated water, and under the influence of an electric current—a current of polarisation, which increased in energy with the number and size of the plates. This kind of battery has been perfected by Messrs. Thomsen and Hjorth, who employed plates of platinised platinum.

But platinum is expensive. It has been left to the ingenuity of M. Planté, the inventor of the process of employing anodes of lead in galvanoplastic work, to devise a still more powerful combination. M. Planté found that simple electrodes of lead give an inverse electro-motive force of two-and-a-half times superior energy to that derived from plates of platinised platinum; and six-and-a half times greater than from plates of ordinary platinum; and he consequently sought to combine a battery founded upon the substitution of plates of lead for the plates of platinum.

The first method invented bears date 1860; but since this time M. Planté has, in a practical point of view, considerably perfected the arrangement, and has given various forms to the component elements. Eventually he has arrived at the form shown in Fig. 13. Each element of the battery is composed of two long and large plates of lead, wound into a spiral, and separated from one another by two or three pairs of india-rubber bands, C C'. These plates are plunged into a glass vessel containing acidulated water (1 part of acid to 10 of water). As in this system of electrolisation there is no disengagement of gas, the hydrogen being absorbed by the peroxide of lead which forms the positive electrode, the elements can be hermetically sealed, and can remain charged without the necessity of renewing the liquid, for none is lost by evaporation.

FIG. 13.

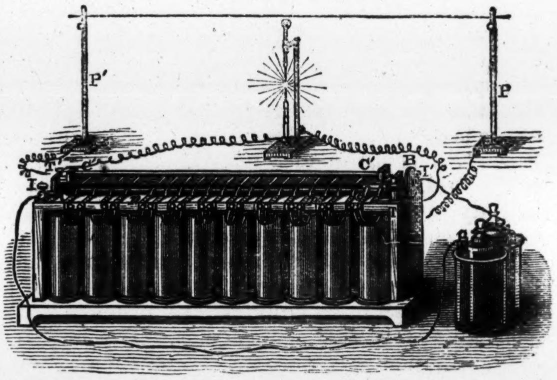


When the battery is composed of only one element of large surface, the cover of the vessel may be of vulcanite, carrying the metallic terminals intended to form the secondary circuit. The couple being about to be charged, the extremities of the two plates of lead communicate with the binding-screws, G H, Fig. 13, and by these with two small Bunsen's elements, and with the bands of copper, M M'. The copper band M is placed directly beneath another plate, or band of brass, R, which forms a spring capable of being put into metallic connection with M, by means of the button, B. As this spring R communicates with the terminal A, the plate of lead corresponding to M can, at will, be put into metallic connection with the terminal A. The band M' is, on the other hand, in constant communication with the terminal A'. Between the terminals A and A' may be placed a short platinum wire, intended to be fused, or to be rendered incandescent by the passage of the secondary current.

The plates of lead, of the apparatus represented in Fig. 13, are 1 foot 6 inches in length by 7 inches in width, so that the total surface is equal to about 126 square inches. When this couple has been well charged it will maintain a platinum wire, 1 millimetre diameter, at a red heat, for 1 minute, or fuse a steel wire of the same diameter.

When the battery is composed of several elements, and it is desired to join them up for tension, as in Fig. 14, the plates are 4 inches wide by 6 inches in length, and the surface consequently 24 square inches. The plates of each couple are about 1-10th of an inch apart. The couples are arranged in two rows to the number of twenty, and communicate with the springs of a commutator, intended to join up the surfaces of the plates successively for quantity during charging, and for tension during the discharge. The commutator consists of two cylinders, C C', Fig. 14, of which one is intended to connect the even poles of the secondary couples, the other the odd poles of the same couples, by means of the springs, R. These two cylinders are connected to a rod of some insulating material placed between them, and carrying plates of copper arranged obliquely to its surface. These plates are intended to rub, at any given moment, against the springs, R. By a quarter-turn of the axis of the rod the couples can be joined in quantity or in tension. In order to charge the battery the poles are connected to the primary battery, which may consist of two or three Bunsen elements. The poles of these elements, arranged in tension, are connected to the terminals, I I', these terminals being in connection, by means of springs, with the cylinders, C C'. The current divides itself between the twenty couples forming the battery, and developes in each a contrary electro-motive force equal to 1 or 1½ times that of a couple of Grove or Bunsen element. The Bunsen charging-battery, of 2 or 3 units force, thus developes a contrary electro-motive force of 30 units when the twenty secondary couples are arranged in tension.

FIG. 14.



When the battery is charged, by turning the button, B, the arrangement of the series in tension is at once effected. By employing forty couples, or by uniting two batteries, there may be obtained during the discharge an electro-motive force equal to that from 60 Bunsen elements,—sufficient for the electric light, or to heat to redness a platinum wire

2 metres in length and 0·5 m.m. in diameter. The same apparatus, although intended more particularly for effects of tension, can be arranged with equal facility for the manifestation of effects of quantity. The entire surface of the pile thus arranged would develope, at the moment of breaking circuit with the primary battery, a sufficient quantity of electricity to fuse a platinum wire of 2 m.m. diameter, stretched between the supports, P P′.

A peculiar phenomenon presented by this secondary battery is its property of affording, similarly to a Leyden jar, several residual discharges, which have a certain energy, and are always in the same direction.

It is known that currents of polarisation, when allowed to remain, diminish in intensity: the time necessary to complete the discharge from M. Planté's pile varies from 10 to 15 minutes. But having almost discharged a battery of this kind, if the circuit is then broken for about 15 minutes a fresh action is set up. This action, although less intense and of less duration than the first, is still very energetic. By breaking the circuit at different intervals, as many as six successive discharges may be obtained. These residual discharges are due to the hydrogen not at once completely deoxidising all the peroxide of lead. At the first formation of the secondary circuit the surface of the layer of peroxide loses its excess of oxygen, and is reduced to the state of protoxide. The plate not oxidised by the current from the primary battery becomes, under the influence of the secondary current, coated with a very slight layer of peroxide, giving rise to a current in the opposite direction to the secondary current. If the circuit is kept open for a short time the peroxide of the second plate is deoxidised by the liquid, and this plate is again in a neutral state with regard to the first, upon which the peroxide still possesses activity, and gives rise to a renewed secondary current on re-uniting the circuit.

The time necessary to impart a maximum charge to a secondary couple varies, with the size of the plates, from 8 to 20 minutes, the primary battery consisting of two Bunsen couples. The indication of the maximum charge of the secondary pile is the formation of bubbles of gas, arising from the decomposition of the water. The duration of the discharge varies, with the resistance in circuit, from 1 minute to 8 or 10 minutes. On disconnecting the poles of the primary battery, the secondary battery may remain with open circuit for 48 hours before the charge will have entirely disappeared.

Finally, it is not necessary to employ a large battery in order to obtain useful results. Two small lead wires, subjected to the action of a primary current for a few seconds, will furnish a secondary current of sufficient strength to demagnetise an electro-magnet carrying 200 grms.

In a future paper we shall deal at length with the phenomena of polarisation.

Travelling Telegraph Office.—The travelling telegraph office has been on view at the Agricultural Hall, Islington, during the Cattle Show. It is stated that already close upon 15,000 messages have passed through this curious "office on wheels" since its establishment in April last, and that it has travelled little short of a thousand miles in that time, during which not a single hitch or breakdown of any kind has occurred.

ON THE USE OF ELECTRO-MAGNETIC INSTEAD OF ELECTRO-STATIC INDUCTION IN CABLE SIGNALLING.*

By G. K. WINTER. F.R.A.S.,
Telegraph Engineer, Madras Railway.

There can be no doubt that the commercial success of the submarine cables that at the present time encircle the globe is, in a great measure, due to the method of working by means of the condenser invented by Mr. Varley, and patented by him in 1862. About two years ago I thought I had invented a new method of working, namely, by causing the rise and fall of the strength of the current to give signals to the receiving instrument, instead of using the direct action of the current. I was unaware how completely my idea was anticipated by Mr. Varley until after my return to England a few weeks ago, when I had an opportunity of reading the specification of the patent referred to, an advantage my long residence in India had previously denied me. The great success I met with, however, in an actual trial of the method I had re-invented, induces me to hope that a short description of it may be of some value; especially since, as far as I am aware, the method was merely suggested by Mr. Varley as being possible, and never before, to my knowledge, submitted to the test of experiment. The sending apparatus being the same as that now in use, the currents from the cable were made to pass through a long fine primary wire of an induction coil, and the induced currents in the secondary wire were made to work the galvanometer or other receiving instrument. In the rather rough instrument with which my experiments were made, the core consisted of a soft iron rod, 1½ inches in diameter and 2 feet in length; the primary wire consisted of two parallel No. 35 silk-covered copper wires, its resistance being about 2500 B. A. units. The secondary wire consisted of two parallel No. 14 cotton-covered wires, its resistance being about 2½ B. A. units. The receiving instrument was an ordinary Thomson's galvanometer with a moderately thick fibre, the resistance of the coil being about equal to that of the secondary wire of the induction coil. Through the kindness of the electrician and superintendents of the Singapore and Madras cable, I was able to try the apparatus on that line. The experiment was exceedingly successful, as many as fifteen words per minute being read without much difficulty. The signals were somewhat similar to those with the condenser method; but the elements of the letters were more distinct, and the vibrations, which on one of the occasions were very annoying with the ordinary method, entirely disappeared when the induction coil was in circuit. The Singapore cable is about 1800 knots in length, and has a resistance of about 10 ohms per mile. An advantage, which I think should not be overlooked, possessed by this method over that with the condenser, is, that during the prevalence of the intense earth currents which accompany magnetic storms, the cable is only dynamically, instead of statically, charged, and hence there is much less danger of damage to the insulator. In the case of shorter submarine cables, and even land lines where the Morse instruments are used, this method, though requiring more battery power, would to a very great extent, if not entirely, prevent the delays occasioned by these earth-currents. I was first led to this idea in an endeavour to produce a recording instrument for long submarine cables, and for this purpose attempted to work a delicate relay by the induced current, the relay tongue being so adjusted as to remain against either contact-point until forced against the other. On land lines and short submarine cables this is quite possible; but on long cables, unless we use a very large battery power, the rise and fall of the strength of the current would not be sufficiently rapid to generate secondary currents of sufficient strength to work a relay. A very few words will explain my meaning. If a series of discontinuous currents be sent in at one end of a cable the curve of the arriving current at the other end will be such, that for a time approximately equal to that of the battery contact of the far end the receiving current will be rising in strength, and for a time approximately equal to the suspension of the contact the received current will be falling. The effect is increased if a reversed current is used instead of the simple suspension. Now if this received current be made to pass through the primary wire of an induction coil, the induced currents will be in one direction during the increase of the cable current, and in the opposite direction during its fall: we thus have, say, plus currents corresponding with the battery contacts at the far end, and minus currents corresponding with the intervals, spaces, reversals: if these induced currents are strong enough to work a relay, we at once get a recording instrument free from the embarrassments attending the usual method of working by the direct action of the current; and so far as the earth currents are concerned, they change in strength and direction too slowly to cause induced currents of any consequence in the secondary circuit. Failing, however, to obtain a relay sufficiently delicate to work with the induced currents, I tried the mirror method, and, as already stated, succeeded perfectly, I append an extract from a letter from the clerk in charge of the Madras office, Mr. Gott, who was present during the experiments; and have merely to add, in conclusion, that I shall be fully compensated for the trouble I have taken in the matter if —by thus making public the results of my experiments—I contribute in any degree to the advancement of science or the success of telegraphic enterprise.

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* Read before the British Association, Brighton Meeting.

Mr. Winter then read the following abstract of letter from Mr. Gott, clerk in charge of the Madras Office of the British Indian Extension Telegraph Company:—

"I was at the instrument when Mr. Winter's apparatus and mirror galvanometer were in circuit for two or three hours, on the afternoon of the 19th inst. I observed that the beats on each side were very distinct, and every letter was distinctly formed, and that the slightest space between the letters brought the light back to zero. A number of messages were received without our having to ask for a single repetition. I may say that all those clerks who have had an opportunity of reading by Mr. Winter's system much prefer it to the old one."

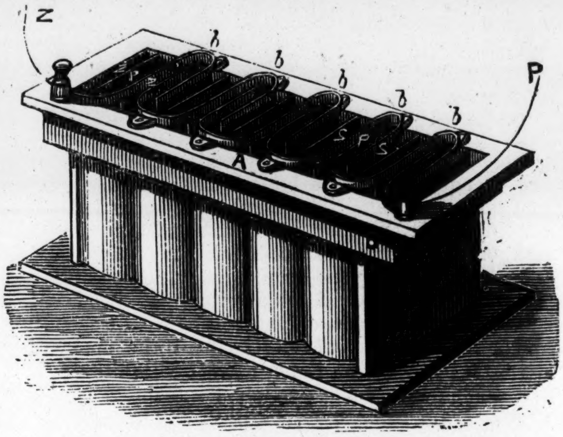
Mr. Lundy, Superintendent B.I.E.T. Co., says—"I can fully confirm these statements, having been present at all the experiments."

AN IMPROVED FORM OF GROVE'S BATTERY.

By HORATIO YEATES.

My improvement in the arrangement of Grove's battery, where a series are required, is to mount the cells in a stand, with a loose wooden frame on the top surrounding the cells and projecting above them about $\frac{1}{4}$ of an inch: across this frame rest brass frames, the shape of a very flat S, to two limbs of each of which are permanently screwed the zinc plates of one cell, and to the third the platinum plate of the next cell. At the bends of the brass frames are lugs with holes in them, which fit on to corresponding pins in the wooden frame, and serve to keep the plates in their proper position. By this contrivance, all the plates being straight, they can be taken out and put in at pleasure, without interfering with the porous cells. When all the cells are charged the plates can be put in their place, and set up ready for use, without requiring any connections to be made, the use of binding-screws, except for the terminals, being altogether dispensed with.

FIG. 15.



A is the loose wooden frame on which the brass-frames *b b b b b* rest, and are kept in their place by the lugs *a' a'* (Fig. 16); P the platinum; and Z the zinc terminals.

FIG. 16.

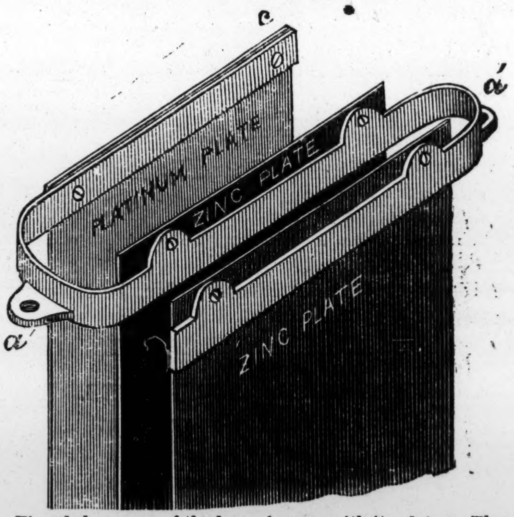


Fig. 16 shows one of the brass-frames, with its plates The zinc plates are attached by two screws at the upper side; the platinum plate is clamped with a strip of brass, also screwed into the frame, and shown at *c*.

To empty the battery after being used all the plates are lifted out together by the loose wooden frame, and by placing a stick across the top of the cells, and holding it in its place at each end, the whole of the contents can be thrown out at once.

AN IMPROVED FORM OF INDUCTION-COIL.

The following particulars of a new coil constructed by Mr. Yeates may not be uninteresting. The effects are remarkable, more on account of their production with a given length and weight of secondary wire than for any extraordinary length of spark. The results were obtained with a Grove's battery of five cells (5 inches × 3 inches).

The coil is wound in two junks, insulated by the interposition of an ebonite disc, in the manner recommended by Dr. Ferguson, by which the terminals of the secondary wire are both brought to the outside, one on each junk. The insulation is carried out according to Mr. Yeates's plan, with gutta-percha tissue and paraffin. The contact-breaker is of the ordinary form, with a simple—though very important—contrivance for insuring a long contact; it consists in a considerable increase of the weight of the armature, and a due amount of elasticity in the spring that supports it, by which the momentum maintains contact during the greater portion of its vibration, a point which is not to be overlooked in the most effective construction of a coil.

The following are the dimensions of the principal parts of the coil:—Core, 22 inches × 1¼ inches diameter; primary consists of 2 layers of No. 12 gauge copper-wire; secondary consists of 55 layers of No. 36 silk-covered wire; 55,000 convolutions; measures 10½ miles, and weighs 10½ lbs, The condenser consists of 66 sheets of tin-foil (11 × 29) insulated with paraffin paper.

With the battery already mentioned it gave 12¾-inch sparks in air, and pieces of ordinary plate-glass were readily pierced.

The following table contrasts the results obtained from Ruhmkorff's large coil (Ganot's "Cours de Physique") with that now under notice.

	Length of Secondary Wire.			Length of Spark in Air.	Length per Mile of Wire.
	Metres.		Miles.	Inches.	Inches.
Ruhmkorff's large coil	100,000	=	62	17¾	0·28
Mr. Yeates's coil.. ..			10½	12¾	1·21

These results are in favour of Mr. Yeates's coil in the ratio of 4·3 : 1.

ELECTRICAL RESISTANCES.

By WALTER HALL.

The following table of diameters and resistances of pure copper wires may not, perhaps, be unacceptable to electrical students and others.

The capacity of pure copper is taken at 100, and the unit of resistance used is the ohmad adopted by the Electrical Committee appointed by the British Association, one unit being equal to 1760 yards, or 1609·31 metres of copper wire 0·2302 inch diameter.

The value of the table consists mainly in its being a standard by which the student is enabled to ascertain the conducting power of any wire he may have under test, and also of its giving relative lengths of pound and kilogrammes, and proportionate diameters in decimals of inch and millimetres.

Diameter of inch $\left(d=\sqrt{\frac{C}{l}}\right)$	Diameter of m.m. (=d × 25·4)	Number of yards per lb. $\left(l=\frac{C}{d_2}\right)$	Number of metres in 1 kilo. (=l × 2·016)	Resistance in ohms. of pure copper (unit of length 1760 yds. or 1609·31 mtrs).
0·2302	5·847	2·095	4·223	1·000
0·2260	5·740	2·175	4·384	1·038
0·1980	5·029	2·834	5·713	1·352
0·1830	4·648	3·317	6·680	1·583
0·1750	4·445	3·628	7·314	1·731
0·1600	4·064	4·350	8·750	2·068
0·1360	3·454	6·007	12·110	2·867
0·1280	3·251	6·781	13·671	3·237
0·1070	2·717	9·705	19·555	4·623
0·1000	2·540	11·110	22·398	5·300
0·0920	2·336	13·125	26·460	6·266
0·0800	2·032	17·360	35·000	8·288
0·0700	1·778	22·670	45·710	10·820
0·0650	1·651	26·290	53·000	12·250
0·0625	1·587	28·472	57·400	13·590
0·0600	1·521	30·864	62·223	14·730
0·5800	1·473	33·030	66·588	15·760
0·0560	1·422	35·432	71·431	16·910
0·0540	1·371	38·104	76·818	18·180
0·0520	1·320	41·091	82·839	19·610
0·0500	1·274	44·444	89·600	21·210
0·0480	1·219	48·225	97·222	23·020
0·0460	1·168.	52·510	105·860	25·060
0·0440	1·117	57·390	115·700	27·390
0·0420	1·066	62·980	126·960	30·060
0·0400	1·016	69·444	140·000	33·140
0·0380	0·965	77·160	155·500	36·720
0·0360	0·914	85·766	172·910	40·920
0·0340	0·864	95·290	292·700	45·480
0·0320	0·813	108·500	218·740	51·790
0·0300	0·762	123·460	248·900	58·930
0·0280	0·711	141·720	285·710	67·650
0·0260	0·660	164·360	331·350	78·460
0·0240	0·609	192·900	380·260	92·080
0·0220	0·558	229·560	462·800	109·580
0·0200	0·508	277·780	560·010	132·590
0·0180	0·457	342·940	691·360	163·690
0·0160	0·406	434·030	875·000	207·170
0·0140	0·355	569·510	1148·100	270·580
0·0120	0·305	771·600	1555·500	368·300
0·0100	0·254	1111·110	2239·800	530·350
0·0095	0·241	1231·100	2481·900	587·640
0·0090	0·228	1371·700	2765·300	654·750
0·0085	0·216	1537·800	3100·200	734·050
0·0080	0·203	1736·100	3500·000	828·670
0·0075	0·190	1975·300	3982·200	942·840
0·0070	0·177	2267·600	4571·000	1082·400
0·0065	0·165	2629·900	5300·000	1225·300
0·0060	0·152	3086·400	6222·300	1473·100
0·0055	0·139	3673·100	7404·900	1753·200
0·0050	0·127	4444·400	8960·000	2121·400
0·0045	0·114	5487·000	11062·000	2619·000
0·0040	0·106	6944·400	14000·000	3314·700
0·0035	0·088	9070·300	18285·000	4329·400
0·0030	0·076	12346·000	24890·000	5892·700
0·0025	0·063	17777·000	35838·000	8485·600

The foregoing table is sufficiently comprehensive, embracing every size of wire likely to be used; but should the student have an intermediate size, he can obtain the diameter for himself as follows:—

d (diameter) $=\sqrt{\frac{C}{l}}$, l being the length in yards of lb., or $d=\sqrt{\frac{0·111111}{28·472}}=0·0625$, corresponding to one of the diameters in table. The value of C is $\frac{1}{9}$th, or 0·11111.

To find the resistance of any other size wire not in the table, proceed thus:—

$$R = \frac{0{\cdot}053035}{d^2},$$ where d represents its diameter.

An easy method of obtaining the conducting power (P) of copper wire, assuming the experimentalist to have ascertained the accurate diameter by the above formula, is to test for resistance (r) by means of the Wheatstone balance, and the conducting power, $P = \frac{R}{r} \times 100$.

As a familiar example, 1 mile of 0·0625 copper wire has, say, a resistance, r, = 16·5 ohms; the value of R in table = 13·59; hence $P = \frac{R}{r} \times 100 = \frac{13{\cdot}59}{16{\cdot}5} = 82{\cdot}36$ per cent of pure copper.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

The first meeting of the session was held on Wednesday evening, November 13th, in the hall of the Institute of Civil Engineers. F. Scudamore, Esq., Director of the Post-Office Telegraphs, took the chair in the absence of Mr. Siemens through ill health.

The paper was a valuable one, by Major Webber, R.E., "*On the Telegraph and the Autumn Manœuvres*," in which an account was given of the proceedings of the telegraph department of the Southern Army.

After acknowledging the assistance which the army received from the telegraphic department of the Post-Office, Major Webber described, with great minuteness, the lines which had been laid down, representing altogether 42¼ miles by distance and 50 miles of wire. The telegraph was 28 days in work. There were many faults found in the cable: the faults consisted principally of the cutting of the wires, and in some instances this was done wilfully, for they found the ends stuck in the earth. Therefore the army telegraphy could not be depended on, and there was a loss to the service and to the Post-Office. The military telegraphs were open for ordinary postal messages, but it carried no other messages, which he thought exceedingly fortunate. The total number of messages carried over the military wires was 487. The actual outlay at the War Office was £235 4s. 4d. His experience was not favourable to covered conductors lying on the ground as a means of communication. The cable system did not turn out well in his opinion, and he would rather not try it again. He should rather go back to the old pole carrying a thin copper wire, which he thought would give them a tolerably reliable line. The lecturer then proceeded to describe the system of visual signalling employed, and the practice of codifying messages, which he thought had little or no value.

Captain Lambert, who conducted the telegraphy of the Northern Army, said that he should be sorry if the meeting separated with the idea that the field telegraphy failed on both sides. On the Northern side it worked fairly and satisfactorily enough. The communication was never interrupted for more than three hours.

Captain Home thought that Major Webber judged his own work too harshly.

M. von Chauvin said that during the late campaign in France they found overhead wires answer very well, but poles were disadvantageous where the position was exposed to the enemy's artillery.

Mr. W. H. Preece said that he had been entrusted with the postal telegraph arrangements during the autumn manœuvres. Over 1300 messages were sent without a single complaint. The newspapers were exceedingly heavy in their demands, and half a million words, representing 300 columns of matter, had been wired.

Mr. Latimer Clark recommended the use of a plough to make a furrow for the wire, and thought the wire should be iron instead of copper, so as not to be worth recovering.

Captain Le Mesurier thought that the visual signals had failed on account of insufficiency of men, want of training, and want of material for lime-lights.

Captain Colomb corrected some statements made regarding visual signalling, and disclaimed being the originator of the scheme.

Mr. Scudamore said that the Post-Office, in supplying the desires of the War Department, had never expected to derive any pecuniary advantage whatever.

Major Webber, in reply to the various speakers, said that he believed there have been fewer failures than were anticipated; the experiences, moreover, would undoubtedly prove profitable.

The Seventh Ordinary General Meeting was held on Wednesday, November 27th, C. W. Siemens, Esq., F.R.S., President, in the chair, when a paper was read '*On Lightning and Lightning Conductors*," by W. H. Preece, Esq., Member Inst. C.E., and S.T.E., &c.

From this paper it would appear that from January 1st to July 31st, 1872, of 9475 instruments of different form in use in the department, 897 or 9·46 per cent were injured.

The following officers for the ensuing year were elected at the general meeting, December 11th:—President—Frank Ives Scudamore, C.B. Past President—C. W. Siemens, F.R.S., D.C.L. Vice-Presidents—Lord Lindsay, Sir William Thomson, and Messrs. L. Clark and R. S. Culley. Council—Colonel Stotherd, R.E.; Professor Foster, F.R.S.; Captain Colomb, R.N.; Major Malcolm, R.E.; Major Webber, R.E.; Professor Abel; and Messrs. E. W. Whitehouse, C. F. Varley, W. H. Barlow, W. H. Preece, and Carl Siemens. Associate Members of Council—Professor Bottomley, and Messrs. J. Bordeaux and H. G. Erichsen. Treasurer—Major Webber, R.E. Honorary Secretary—Major Frank Bolton. Auditors—Messrs. J. Wagstaff Blundell and F. C. Danvers. Secretary—Mr. G. E. Preece.

METEOROLOGICAL SOCIETY.

At the monthly meeting of this Society, on Wednesday evening, November 20th, J. W. Tripe, M.D., President, in the chair, the chief subject under discussion was a paper by Mr. Latimer Clark, F.M.S., "*On the Storms experienced by the Submarine Cable Expedition in the Persian Gulf, on November 1 and 2, 1869.*" The first storm occurred at 9 o'clock at night, when the vessels of the expedition were about 130 miles from Bushire, and burst upon them without any preliminary warning, lowering the temperature by nearly 30° in a few minutes. It was accompanied by heavy rain and much lightning and thunder, and progressed from N.W. to S.E. After the tempest had lasted for two hours the wind changed to a gale from S.E., and subsequently fell calm as before. The next day the cable was spliced up, and paying out had scarcely recommenced, with a strong S.E. wind, when notice was received that another violent storm from the N.W. had passed Bushire, and was on its way down the gulf. At 3·52 p.m. the storm burst forth with the same suddenness and fury that characterised the previous one. Suddenly there came a profound calm, and a few hundred yards ahead the squall was seen approaching. The sun was elsewhere covered with full-sized waves, but under the influence of the hurricane it became one dead level of creamy foam, the top of every wave being swept off into spray as soon as it rose. The squall struck the vessels with the same fury as on the previous evening, and the thermometer fell at once from 81° to 53°; torrents of rain swept the deck, accompanied with continuous peals of thunder. After two hours the sky grew bright, and the wind changed into a gale from the S.E., followed by a calm.

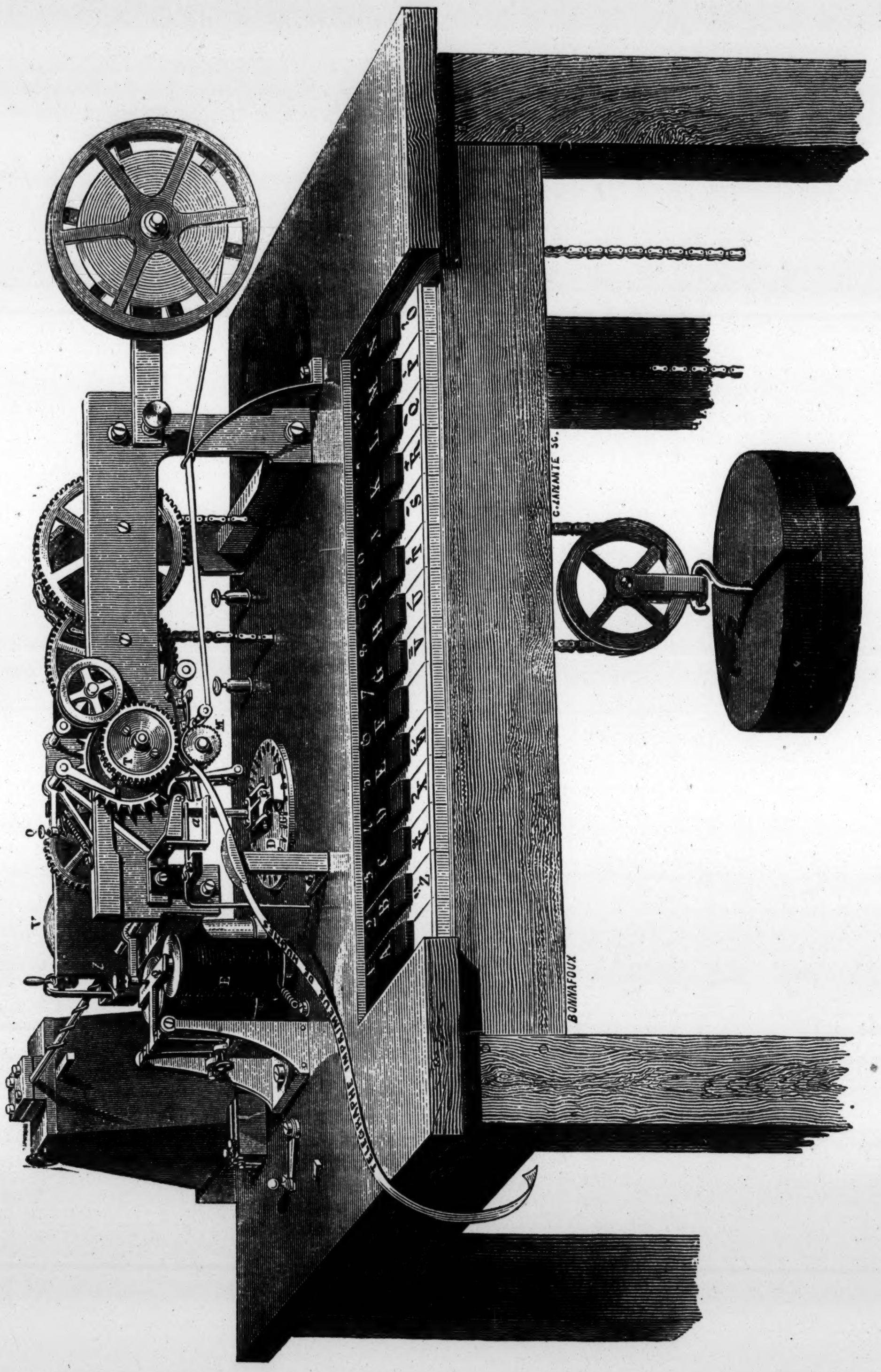


FIG. 17.

Mr. SCOTT, of the Meteorological Department of the Board of Trade, followed with an interesting account of the proposed meteorological congress next year at Vienna.

Twelve new members were admitted.

Students' Column.

IN pursuing our investigation of the laws of the diffusion of the electric current during a variable period, we give this month the laws of the duration of absolute propagation or diffusion, as deduced by M. Gaugain from very numerous experiments. These laws are included in the five following propositions:—

1. In the case where the loss by the air is nil, and supposing that the tension of the source varies without the conductor experiencing any change, the tension

of a determined section of this conductor, at the end of the given time, is always proportional to the tension of the source.

2. Whilst the dimensions of the conductor remain constant, the duration of the absolute diffusion is inversely proportional to the specific conductivity of the conductor, or, in other terms, directly proportional to its specific resistance.

3. When the specific conductivity and the section are invariable, the duration of the absolute propagation or diffusion to the square of the length of the conductor.

4. When the nature and the length of the conductor, as well as the surface, remain the same, and when, by this last condition, the coefficient of charge is also invariable, the duration of the diffusion is inversely proportional to the section of the conductor. The conditions expressed in this last proposition can be realised with a hollow cylinder, in which we can vary the thickness without changing the exterior surface.

5. The nature, the length, and the area of the section remaining the same, if we modify the form of the section in such a manner as to vary the coefficient of charge, the duration of the absolute diffusion is directly proportional to this coefficient of charge.

When the loss by the air cannot be neglected, or, which amounts to the same thing, when the circuit is subject to derivations, the last four laws are altered, the diffusion being much more rapid.

The Hughes Type-Printer.

In order that those among our students whose *penchant* does not lie in the way of mathematical reasoning may find at our table something more to their taste, we give here a description and illustration of Prof. Hughes' type-printer. This instrument, although employed to some extent in the Post-Office service, and in various departments abroad, may be considered as having reached its maximum application; for while so apparently simple it is really complicated, and difficult to learn to manipulate. Notwithstanding these practical drawbacks, we feel that our pages would be incomplete without a description of the instrument, especially as The Telegraphic Journal is intended to form a book for reference, and that this type-printer is the instrument *par excellence* of its day. The marvellously ingenious apparatus was invented by Prof. Hughes about 1859; its principle consists in causing the synchronous movement of type-wheels at two or more stations, and by the aid of a single electric current simultaneously pressing a strip of paper against corresponding parts of the type-wheels. The motive-power is derived from clockwork driven by a weight of 120 lbs., regulated by a vibrating spring, *l*, Fig. 17,* acting upon an escape-wheel, the vibrations of the spring being regulated by a travelling weight. Three shafts are driven by the clockwork; one carrying the type-wheel, T; another carrying the fly-wheel, V, and making 700 revolutions per minute; and a vertical shaft, *a*, having the same velocity (120 revolutions per minute) as the type-wheel, with which it is connected by bevel-wheels. This vertical shaft is in two portions, insulated from each other. At right angles to the vertical shaft is a revolving arm, travelling over the disc, D, pierced with as many holes, G, as there are letters on the type-wheel, these holes being so arranged that the extremity of the arm passes exactly over them. In these holes are the upper ends of a set of pins, which are raised by the depression of the keys bearing the letters of the alphabet. When the arm travels over a pin thus raised, the battery current, which has been previously to earth, passes to the electro-magnet, and thence to line. So far the instrument has been described as a transmitter. As a recording or receiving instrument, the description of Prof. Everett had best be followed. "The current traverses the coils of an electro-magnet, E, beneath which is a permanent steel horse-shoe magnet, having its poles in contact with the soft-iron cores of the electro-magnet. When no current is passing, the influence of the steel renders these cores temporary magnets, and enables them to hold the movable armature, *p*, against the force of an opposing spring. The current is in such a direction that it tends to reverse the magnetism induced by the steel. It is not necessary, however, that it should be strong enough to produce an actual reversal, but merely that it should weaken the induced magnetism of the cores sufficiently to enable the opposing spring to overpower them. This is one of the most original parts of Hughes's apparatus, and is a main cause of its extreme sensibility." The printing-shaft consists of two portions, one of which carries the fly-wheel, V, and turns uniformly under the action of the clock-movement; the other, which is next the front of the machine, remains at rest when no current is passing; but when the armature of the magnet rises, the two parts of the shaft become locked together. The type-wheel can be adjusted by means of the button, Q, the adjustment being usually made before the message begins. The shaft of the fly-wheel carries a cam, which, at each revolution, engages with a very coarse-toothed wheel, set on the same axis as the type-wheel, and pushes it a little forward or backward without detaching it from the driving-gear. Small discrepancies between the velocities of the type-wheel and the horizontal revolving arm are thus corrected as often as a letter is printed, so that the receiving instrument is prevented from gaining or losing on the sending instrument during the transmission of a message.

These are the principles of this instrument; for sectional drawings and details, which we cannot include here, the student is referred to the specifications of the patentee, to the description by Prof. Everett, and to Sabine's "History of the Telegraph."

Electrical Science in Foreign Journals.

(We intend to devote this column to a list of Electrical Memoirs published in Foreign Journals during the month. Those of importance will be either translated in full or given in abstract.)

Comptes Rendus Hebdomadaires des Séances de l'Academie des Sciences, No. 19, November 4, 1872.

The Probable Solar Origin of the Electricity of the Atmosphere.—By M. Becquerel.

Effects of Lightning on Trees.—By M. D. Colladon.

No. 20. November 11.

The Probable Solar Origin of Atmospheric Electricity.—Part II. of M. Becquerel's valuable paper.

No. 21. November 18.

On Magnetic Energy.—By M. A. Cazin.—We translate elsewhere the abstract given in *Les Mondes*.

Les Mondes, No. 10, November 7.

Complete Cure of Local Paralysis by Electricity.—By M. Désiré.

No. 11. November 14.

Projected Submarine Pneumatic Tube between France and England.—By M. Edmd. Martin.

Researches on the Causes and the Laws of the Movements of the Atmosphere.—By Father Solaro.—Book II. Nature of Electricity. Book III. The Wind and Electricity.

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* Prof. Everett's Translation of Deschanel's "Elementary Treatise on Natural Philosophy." Part III. Blackie and Son.

On the Probable Solar Origin of Atmospheric Electricity.—By M. Becquerel.—Extract.

On the Action of a Copper-Cadmium Couple upon a Solution of Sulphate of Cadmium.—By M. F. Raoult.

No. 12. November 21.

The Electric Telegraph in France and Algiers—By M. Alfred Etenaud—Is the title of an important work reviewed in this number of *Les Mondes.*

Permanganate Battery.—Mr. Koosen.—The substitution of a solution of permanganate of potash for nitric acid in Grove's battery.

On the Extinction of the Electric Light by the Approach of a Magnet.—By Prof. Houston.—A translation.

On Magnetic Energy.—By M. A. Cazin.—It is known that *energy* designates certain quantities which are susceptible of equivalence between them in the phenomena of gravity, heat, and electricity. We measure energy in the case of gravity by the aid of the weight of bodies and their altitude; in the case of heat by the aid of weights, specific heat, and temperature; in electricity, by the aid of the quantity of electricity and its *potential function*, a mathematical expression borrowed from the theory of attraction founded upon the hypothesis of electric fluids, and termed in physics the *electrical tension*, measurable by certain methods. But we know no such expression, in experiment or in theory, as *magnetic* energy. We perceive magnetism appear and disappear in a large number of phenomena, while other forms of energy disappear or appear; but we ignore that any relation exists. M. Cazin has given us for the first time the expression of magnetic energy deduced from experiment. On the one part it is a measure of the heat created in the neighbourhood, while the magnetising helix is traversed by an intermittent current, in placing in this neighbourhood the reservoir of a large thermometer. On the other part it is a measure by a suitable method of the quantity of magnetism gained by the field while the current is passing in the helix. Finally, it is a measure of the magnetic moment of the field by means of Gauss's magnetometer. The author has found *that the quantity of heat was proportional to the product of the quantity of magnetism and the magnetic moment.* But heat appears at the interruption of the current only, and, consequently, it is equivalent to the magnetic energy which then disappears. We can, then, take this heat to represent the measure of magnetic energy, and conclude that this energy is proportional to the product $m \times ml = m^2l$; m designating the quantity of magnetism, and l the mutual distance of the two poles from the magnetic field. If we adopt for the unit of magnetic energy that of a magnet which possesses a unit of magnetism, and of which the polar distance is equal to unity, the quantity m^2l measures numerically this form of energy. The law found by M. Cazin is analogous to that of Joule and Riess for the voltaic current, and for the discharge of a Leyden battery; it establishes a new link between magnetism and the other physical forces; and it leads to the measure of the mechanical equivalent of magnetism.

La Revue Scientifique, No. 22. Nov. 30.

This number contains nothing of electrical interest.

Bulletin de la Sociéte d'Encouragement pour l'Industrie Nationale, No. 240. December, 1872.

On the Balance-Galvanometer of M. Bourbouze.—A Report by M. Lissajous.—This galvanometer is well adapted for the lecture table. Sensitiveness is gained by balancing the magnetised needle upon a knife-edge in the centre of a hollow coil. At right angles to the needle, which works like the arms of a balance, there rises a perpendicular index, playing laterally over a scale. By a counterpoise to this index the sensitiveness can be increased or lessened.

Annalen der Physik und Chemie (Poggendorf). No. 10.

This number contains no article of electrical interest.

The American Journal of Science of Arts, No. 23. November, 1872.

On the Allegheny System of Electric Time Signals.—By Prof. S. P. Langley.—An admirable system, worthy the consideration of our railway and other companies.

On the Nature and Duration of the Discharge of a Leyden Jar Connected with an Induction Coil.—Part III. By Prof. Rood.—We shall give this paper in full.

City Notes.

During the last few weeks telegraph shares have continued to increase in public favour as a class of investment; for the success which has attended an enterprise of such magnitude as the Australian line has naturally inspired confidence in the other schemes now before the public. This description of property is no longer regarded as so hazardous as it was a short time ago; and Mr. Abbott remarks, in his Circular, that submarine cables—when properly manufactured and submerged—are actually less exposed to risk and uncertainty than almost any other description of joint-stock enterprise. The banquet held at the Cannon Street Hotel on the 15th ultimo, to celebrate the successful completion of the Australian line, doubtless exercised a beneficial influence, if only by making it manifest that the official reserve towards, and neglect of, the interests of telegraphy are now rapidly passing away. At present considerable pressure is being put upon the directors of the various companies to induce them to amalgamate: it seems, however, as if the different governing bodies were not merely quite disposed to move in this direction of their own accord, but also to labour for the oonsolidation of telegraphic communication throughout the entire world. The registration, the other day, of the Globe Telegraph Company may be taken as a favourable omen, and the undertaking promises well, as the directors are for the most part the leaders of the telegraphic interest, and are, it is said, themselves large holders of stock in this particular enterprise. We shall, in all probability, ere long, see a complete amalgamation of all the lines east of Bombay, while there is a fair prospect of Australia coming forward with the offer of a subsidy. The further consolidation of the Atlantic lines has received an additional impetus by the establishment of the Newfoundland line as an English company, under the title of "The New York, Newfoundland, and London Telegraph Company," with an authorised capital of 6,000,000 dollars. The company has exclusive working agreements with the Anglo-American, French Atlantic, and Western Union Telegraph Companies, for fifty years, from January, 1870. Under these agreements the cable receipts belonging to the Anglo-American, French Atlantic, and Newfoundland Companies, form a joint purse. Messrs. J. S. Morgan and Co., of 22, Old Broad Street, E.C., have been authorised to offer for sale by public subscription, in London, 33,500 shares in this Company, of 100 dols. each, fully paid up, being more than three-fourths of the 43,176 shares constituting the whole of the issued capital of the Company. These 33,500 shares have been acquired with the view of concentrating the management of the Atlantic Telegraph traffic in London. With this object, it is intended that as soon as possible after the allotment all the present directors, except Mr. Cyrus W. Field, should retire, and that the Board should be constituted as follows:—Sir James Anderson (Managing Director of the Eastern Telegraph Company); Julius Beer, Esq. (Director of the Eastern Telegraph Company); E. L. S. Benzon, Esq. (Messrs. Naylor, Benzon, and Co,); Cyrus W. Field, Esq. (Director of the Anglo-American Telegraph Company); Henry Weaver, Esq. (General Manager of the Anglo-American Telegraph Company), Managing Director. Inquiries having been made as to the liability of shareholders in the New York, Newfoundland, and London Telegraph Company, it may be as well to mention that the liability is strictly limited to the amount of the shares held.

Other subsidiary schemes for the consolidation of existing telegraph lines are in progress.

The second ordinary general meeting of the China Submarine Telegraph Company was held, on the 13th ult., at the Office, Mr. John Pender, M.P., in the chair. We gave last month a short summary of the preparatory report of the Company which was issued, and need, therefore, now only say that at the meeting Mr. Pender stated that since the opening of the line it had worked most satisfactorily. In repairing the cable at Saigon, it was found to be as perfect as the day it was submerged. Even taking into account the low scale of charges, the returns were about as good as those of any cable during its first year. A dividend of 8 per cent for the whole year was announced.

With regard to the W. I. and Panama Company the contractors had succeeded in recovering the cable which was broken, more than two years ago, between Jamaica and Colon. Both the cables of the International Ocean Telegraph, from Florida to Havannah, were at present broken, but the Board trusted that they might soon be repaired. The Company are involved in an unfortunate misunderstanding with their contractors. The cables which were laid up to June last have been carefully examined under the direction of Sir Samuel Canning, and from his report it appears that the insulation resistances are much lower than required by contract. This forms an important feature in the question at issue with the contractors; but it has been resolved to refer the whole dispute to some independent commercial men,—and Mr. Cyrus Field, Mr. Lightly Simpson, and Mr. Greenwood, were appointed to confer with the directors on the subject. Mr. Davis, however, in his speech at the meeting, took a very sanguine view of the position of the Company, announcing his expectation that when the lines were completed the revenue would amount to £108,000, which would be increased by subsidies to £120,000. The expenses he put down at £20,000, thus deducing a profit of £100,000, which would pay a dividend of 14 per cent. It is scarcely probable, however, that this flattering prospect will be realised, when we consider that the working expenses of half the line have hitherto been about £19,500.

The general meeting of the Eastern Telegraph Company was held on the 6th inst. Mr. John Pender, M.P., who was in the chair, remarked that it was the first general meeting since the amalgamation of the four companies, and as a result of this consolidation it would be necessary to provide for an extension of capital. The special object of the meeting, however, was to ask for permission to duplicate the cable between England and Lisbon. Great faults were being found that this city was not getting fair play in the matter of telegraphic communication, while complaints were also emanating from Egypt. The Company had about £14,000 worth of cables in store to lay down between the islands of the Levant, but they must have a new one for Lisbon, or some other association would step in and put one down. The traffic was increasing, and it would soon be still further augmented by the new line from Lisbon to Brazil. He, therefore, moved for the issue of hitherto unissued shares to meet the expenses of the Levant and Lisbon cables, the latter of which would cost £258,000. Sir James Anderson seconded the motion. Mr. Ford said that the directors could raise £403,000 without appealing to the shareholders. The chairman said that it was necessary to set about laying the Lisbon cable as soon as possible, as they had only eight months to do it in, and a delay might cause them to lose the concession. Long before Government could be got to move in the matter of purchase, the cables would be laid and be at work. The Government might have bought all the land telegraphs in this country for £3,000,000, but they put it off till they had to give £7,000,000. The original resolution was carried unanimously.

The pressure in the money market on Nov. 11th caused a general fall, but during the week prices had steadily improved. During the week ending Saturday, Nov. 23rd, some depression was occasioned in various descriptions of telegraph shares by sundry adverse reports—one of which was a statement from Port Darwin that the Australian land line was temporarily interrupted south of Charlotte Waters; but the general state of the market showed no want of firmness in any branch. During the week ending Saturday, Nov. 30th, telegraph shares fluctuated less than has been usual for some time, and beyond a slight alteration in those most speculated in of late, viz., various Eastern and Australian, there was little change worthy of remark. During the week ending Saturday, December 7th, there was some slight fluctuation, and a more decided downward tendency was apparent.

The Eastern Telegraph Company announce a dividend of 3s. per share for the quarter ending the 3rd inst. Complaints, it may be observed, have been made as to the delay in paying the dividends of this Company. We understand that the June dividend was not payable until September, and that the payment of the September dividend has not yet been made. It is all very well to have quarterly payments, but it would be advisable to allow less time to intervene between the day they are due and the time they are paid.

Proposals are expected to be made before the end of the year for effecting submarine telegraphic communication with the Cape, with New Zealand, and with Central America, especially with the Republic of Costa Rica. The collapse in the Stocks of the Central American States is, however, a great impediment in the way of more money being invested in that direction. With the projected Cape and New Zealand cables, the case being different, the required capital will be readily found; and it is probable that before long we shall hear of a cable being projected between our Australian colonies and San Francisco.

The second section of the Russian telegraph line to Turkestan was opened on the 12th of September, from Semipolatinsk to Surguipol, and is found to work admirably.

A Company, it is stated, is now in course of formation to lay a submarine cable from Rangoon to Singapore, touching at the Andaman Islands, Penang, and Malacca.

The manufacture of the duplicate French Atlantic and Great Western cables is steadily progressing at the Telegraph Construction and Maintenance Works at Greenwich; a considerable portion of the former is already coiled on board the *Great Eastern*, and the electrical condition of the cable is all that can be desired.

The Indo-European Telegraph Company have given notice that they are now again accepting messages for India, China, and Australia, their special wires *via* Teheran, interrupted by the late unusually severe storms in North Germany, having been repaired, and placed in good working order again.

The India-Rubber, Gutta-Percha, and Telegraph Works have successfully submerged the cable between Bilbao and the Lizard, and it is now open for messages. Last Monday the Lord Mayor received the following message:—"The Alcade of Bilbao, in the name of the

Ayuntamiento, sends respectful greetings to Senor the Alcade of London on the successful completion of the means of telegraphic communication between the two ports."

The traffic returns on the Great Northern Telegraph Company's lines for the month of November were as follows:—On the European lines—November, 1872, revenue 105,232 francs, as compared with 90,922 francs in November, 1871. On the China and Japan lines—November, 1872, revenue 102,645 francs, as compared with 50,810 francs in November, 1871.

The following remarks of the *Money Market Review* are worth quoting:—" We see it stated, upon the best authority, that the whole amount of joint-stock capital now invested in telegraphs, and which scarcely exceeds ten millions, is held by some fourteen thousand proprietors. When it is borne in mind that some portion is owned by great capitalists, who hold individually their £20,000 or £30,000 of stock, it will be seen that the total is, as a rule, subdivided into very small individual amounts. The power and number of this interest will go on constantly extending. It is wonderful to contemplate the amount of benefit which the investment of this sum of ten millions has brought about. Rarely in the history of the world has money been employed to better advantage."

Post Office Telegraphs.

The official return, made in pursuance of the Act of Parliament, shows that the gross amount received in the year 1871 by the Telegraph Department was £1,133,575, from which must be deducted £401,210 for the amount paid to the submarine telegraph companies, being message receipts collected on their behalf, and the amount allowed to postmasters in respect of sums paid by them for the special delivery of messages, &c. This reduces the year's receipts proper to £732,365. Sums amounting to £487,544 were expended in the year in repect of salaries, rent, maintenance of telegraphs, &c. This left a balance of £244,821 applicable to the payment of annuities or interest falling due upon the securities issued under the authority of the Telegraph Act of 1869, and as a sinking fund for the redemption of such securities.

The undermentioned postal telegraph offices have been opened since our last issue:—Bassingham, near Newark; Bolsover and Brimington, near Chesterfield; Castle Acre, near Brandon; Crich, near Derby; Danbury, near Chelmsford; Girlington, near Bradford, Yorkshire; Great Baddow, near Chelmsford; Great Haywood, Staffordshire; Hatfield Peveril, near Chelmsford; Helperby, near York; Higher Broughton, Manchester; Hylton, near Sunderland; Ketton, near Stamford; Kilkhampton, North Devon; Litcham, near Swaffham; New Fletton, near Peterborough; Norbiton, Kingston-on-Thames; Overseal, near Ashby-de-la-Zouch; Pill, near Bristol; Pinner, near Watford; Prestwich, near Manchester; Rougham, near Brandon; Staveley, near Chesterfield; The Hythe, Colchester; Tolleshunt D'Arcy, near Kelvedon; Tovil, near Maidstone; Upper Mill, near Manchester. The undermentioned railway station will be opened for the transaction of telegraphic business on behalf of the Postmaster-General:—Fawkham Station (London, Chatham, and Dover Railway).

The following statement shows the total number of messages forwarded from Postal Telegraph Stations in the United Kingdom during the last few weeks, and during the corresponding weeks of 1871:—Week ended November 16th, 1872, total number of messages, 306,951; week ended November 18th, 1871, total number of messages, 259,238; increase in the week of 1872 on that of 1871, 47,713. Week ended November 23rd, 1872, total number of messages, 302,664; week ended November 25th, 1871, total number of messages, 241, 465; increase on the week of 1872 on that of 1871, 61,199. Week ended November 30th, 1872, total number of messages, 298,917; week ended December 2nd, 1871, total number of messages, 237,461; increase in the week of 1872 on that of 1871, 61,456.

Experiments have been recently made in the Central Telegraph Station in London to work in both directions on the same wire at the same time; and the result, so far, is eminently satisfactory. The trials were being carried on between London and Southampton, and it is stated that as many as 90 messages have been transmitted in a single hour by this interesting and economical mode of working. This is fully twice the speed at which messages are transmitted by the ordinary mode of working.

The Orkney and Shetland Telegraph Company have sold their plant to Government, and the line will henceforth be worked in connection with the Post-Office. The cost of messages sent southward through the Pentland Firth cable has for some time been 2s. for twenty words. The telegraph has been interrupted for a month or two, and for several weeks the *Caroline* has been lying at Longhope waiting favourable weather for rectifying the fault. According to the *Scotsman* these defects are much greater than were at first supposed, and have necessitated the lifting of the entire cable from Caithness to Orkney, a distance of about fourteen miles. At various places the outer wire coating was found to be cut through, at others the twinings of the wire were unlaid, and the cable was otherwise much chafed. A month must elapse before the cable will be ready for re-laying, as wherever any defects appear it will have to be cut, tested, and spliced anew. From the very exposed route in which the cable was laid, it is doubtful whether it will remain workable for any great length of time in the position in which it has hitherto lain, the ground being composed of sharp rocks for the greater part of the way, especially at the Orkney side, and the current at spring tides in the Firth very strong, running at the rate of eleven knots an hour. To resist the friction arising from such a current would require a cable weighing about twenty tons to the mile, whereas the cable now about to be re-laid weighs only about five tons to the mile. It is considered that if the route from Holborn Head in Caithness, to Stromness in Orkney, by Hoy Sound, were chosen, the current would not be felt nearly so much, and the ground not being so rocky, would be better adapted for a cable route.

On the 21st ult. the messengers employed in the Postal Telegraph Service in Dublin struck for higher pay and other concessions. The rate of remuneration has heretofore been ½d. per message when delivered within a certain radius. An advance to 1d. was demanded, and, on being refused, a strike was announced. We gather from official sources that the business of the department was not seriously impeded, and that the messengers have since asked to be allowed to return.

The new building for the London General Post-Office is nearly finished, and preparations are being made for the transference to it of the Telegraph Department.

Some idea of the progress of telegraphy in New Zealand may be formed from the following statistics:—In 1867 there were 1,447 miles of wire in the colony, and the amount received for telegrams was £14,295. In 1870 there were 3,159 miles of wire, through which 181,860 private, and 56,335 Government messages were sent, the sum total charge for which was £27,422. Since then the progress made has been very considerable, but we are not in possession of returns indicating its amount.

TELEGRAPH SHARE LIST.

Amount per Share.	Name of Company.	Amount paid up.	Nov. 22nd.	Nov. 29th.	Dec. 6th.	Dec. 11th.
£		£				
Stock	Anglo-American (Limited)	100	130 132	131 132	129 131	129 131
10	British Australian (Limited)	All	9½ 10	9½ 9¾	9¾ 9⅝	9½ 9¾
10	British Indian Extension (Limited) ..	All	14½ 14¾	14⅜ 14⅝	13⅞ 14⅛	13¾ 14⅛
10	China Submarine (Limited)	All	10⅛ 10⅜	10 10¼ x d	10 10¼	9⅞ 10⅛
10	Cuba (Limited)....	All	8¾ 9¼	8¾ 9¼	8¾ 9¼	8¼ 9¼
10	Eastern (Limited)	All	10⅜ 10⅝	10½ 10¾	10⅜ 10⅝	10⅜ 10⅝
10	Great Northern	All	10¾ 11¼	10⅞ 11⅛	10¾ 11¼	10¾ 11¼
10	Gt. Northern China and Japan Extension	All	— —	— —	— —	— —
10	Hooper's Telegraph Works	All	9¼ 9¾	10¼ 10½	10¼ 10¾	10¼ 10¾
50	India-Rubber, Gut. Per., and Teleg. Works	45	39½ 40½	38 39	39 40	39 40
25	Indo-European (Limited)	All	14 16	14 16	14 16	14 16
10	Marseilles, Algiers, and Malta..	All	— —	— —	— —	— —
10	Mediterranean Extension (Limited) ..	All	6½ 7	6½ 7	6½ 7	6½ 7
10	Ditto 8 per cent Preference ..	All	11 12	11 12	11 12	11 12
10	Panama and South Pacific (Limited)	2½	— —	— —	— —	— —
8	Reuter's (Limited)	All	9½ 10½	10 10½	9½ 10½	9½ 10½
20	Soc. Transatlant. Fran. (Limited)	All	25½ 26	25½ 26	25½ 26	24¾ 25¼
20	Ditto New	15	5⅛ 5⅜ pm.	4½ 5 pm.	4 4½ pm.	4 4¾ pm
Stock	Submarine	100	215 225	200 220	200 220	200 220
1	Ditto Scrip	All	2 2¼	1⅞ 2⅛	1⅞ 2⅛	1⅞ 2⅛
12	Telegrph. Construction and Maintenance	All	31¼ 32	32 32½	31¼ 31¾	31½ 32
10	West India and Panama (Limited) ..	All	6½ 7	6½ 7	6¾ 6⅞	6¼ 6¾
1000 dls.	West Un. U.S. 7 per cent 1st M.B. ..	All	200 205	— —	— —	— —

Patents.

Communicated by Messrs. Vaughan and Son, Patent Agents, 54, Chancery Lane, London.

Applications for Letters Patent.

3299. W. R. Lake, Southampton Buildings, London, "Improvements in electric torches for lighting gas."—A communication from W. W. Batchelder, New York, U.S.A.—Dated November 7, 1872.

3340. C. E. Zindars, Red Lion Square, Holborn, Middlesex, "Improvements in pneumatic signalling and communicating apparatus."—Dated November 9, 1872.

3344. J. B. Stearns, Boston, Mass., U.S.A., "Improvements in electric telegraphs."—Dated November 11, 1872.

3368. C. A. Randall, New York, U.S.A., "Improvements in printing telegraphic apparatus, and in the arrangement of the circuits to be used in connection therewith."—Partly a communication from S. M. Foote, New York.—Dated November 12, 1872.

3462. J. Thomas, Bangor, North Wales, "Improvements in supporting and protecting telegraph wires."—Dated November 20, 1872.

3474. S. F. Van Choate, Boston, Mass., U.S.A., "Improvements in the mode of and apparatus for telegraphing."—Dated November 21, 1872.

3512. C. Owen, City Road, London, "Improved means for electrical intercommunication between passenger and guard, and guard and engine-driver."—Dated November 23, 1872.

3548. W. Young, Blandford Square, Middlesex, "Improvements in electric telegraph apparatus, partly applicable for printing and producing stereotyping and printing surfaces."—Dated November 26, 1872.

3586. G. Haseltine, Southampton Buildings, London, "Improvements in printing-telegraph apparatus."—A communication from E. Gray, and E. M. Barton, Chicago, Ill., U.S.A.—Dated November 28, 1872.

3672. A. S. Owen, Cornhill, London, "Improved means for obtaining electric currents."—A communication from W. C. Tellchert, Vienna, Austria.—Dated December 4, 1872.

Notices to Proceed.

3262. G. Zanni, City Road, Middlesex, "Improvements in magneto-electric railway-block and other day or night signalling instruments or apparatus, and in means for communicating signals from one part of a railway train to another."—Petition recorded November 2, 1872.

PATENTS GRANTED.

1279. H. Highton, M.A., Putney, Surrey. *Submarine or other cables for the conveyance of electricity.* Dated April 29, 1872.—The application to the conducting wires of cables which are covered with gutta-percha or caoutchouc, or similar materials, of a solution of paraffin, or ozokerit, or shellac, for filling up the minute pores and improving the insulation, or the coated wire may be with the same object rubbed with a volatile solvent.

1320. W. A. Lyttle, London. *Telegraph wires.* Dated May 2, 1872.—1. Securing the telegraph line wire to the insulator by a staple or U-shaped clip fitting the circular groove in the top of the insulator, threaded and nutted at the ends, and provided with a cross piece of metal or ebonite extended from one leg to another. Against the cross piece the telegraph wire is clipped by the nuts when tightened, and between the cross piece and the bend of the U the insulator is clamped fast. If the insulator is made specially to suit for this arrangement, the wire can be clipped home against it without a cross piece. 2. Clamping home against the telegraph wire and insulator as described, a cylindrical or otherwise-shaped metal shield open at both ends as a protection against breakage. 3. The use of a shield open at the top, and similarly constructed with other forms of insulator to which the U clip will not apply.

1334. W. Darlow, North Woolwich Road, Essex. *Portable magnets.* Dated May 2, 1872.

1376. D. G. Fitzgerald and B. C. Molloy, London. *Treating compound substances by the agency of electricity.* Dated May 6, 1872.—A tank is used with carbon electrodes; also a magnetic electric machine, driven by steam or otherwise.

1378. W. R. Lake, London. *Electric torches for lighting gas.* Dated May 6, 1872.

1412. M. H. Larmuth, Salford, Lancashire, and F. Norton, Manchester. *Standards or supports for telegraph wires.* Dated May 9, 1872.—Standards for supporting telegraph wires, of clusters of metal rods, bars, or tubes, connected together by cast-iron or malleable cast-iron frames. The insulators are fixed to the upper end of the standards, or to frames affixed thereto.

1428. H. Highton, Putney, Surrey. *Electric telegraphs.* Dated May 10, 1872.—A gold or silver leaf, deflected by a current of electricity passing through it when placed in a magnetic field, is caused to complete by its motion a secondary circuit, so as to work a secondary or other instrument, or a relay.

1439. A. Ray, Guildford. *Transmitting telegraphic* *signals.* Dated May 11, 1872.—This system comprises —1. To keep up along the line, during all the time of the transmission, a constant current, which has no other end but to annul all the resistances. 2. To throw along this line, and in the same sense as the constant current, a broken current, the functions of which is to transmit the signals. 3. To place under the pliable iron bars of the electro-magnet of the receptor such a magnet as might neutralise the magnetism produced into the helix by the passage of the constant current.

1447. J. A. Desgoffe, Paris. *Telegraph posts.* Dated May 13, 1872. This invention consists in making the posts of sheet-iron, which is cut in lengths; it is then submitted to a screw press bearing a longitudinal bar of iron of the form it is desired to impart to the sheets: this being effected, they are united at the rim or wings by means of rivets or bolts. The insulators are attached as desired, either to the posts or mounted on arms connected to them, or they may be fixed alternately on the posts and on the arms: this is the method adopted when there are a number of wires. The posts being hollow, the wires pass down the centre, and, uniting, form a cable at the foundation, whence it may be directed in any desired direction: this occurs with terminal posts, and posts at crossings. In order to secure the requisite equilibrium and solidity, the sheets of metal gradually increase in thickness as they reach the bottom of the posts, which latter may be galvanised, coated with coal-tar or cement, or other substance, to guard against deterioration. By placing a box or compartment containing the requisite apparatus for testing the wires in the interior of the post at any desired point on the route, and allowing them to enter therein, any defect in the circulation of the electric fluid may be ascertained, and its position determined.

1453. T. A. Edison, Newark, U.S. *Printing-telegraphs.* Dated May 13, 1872.—The electro-magnets in this printing-telegraph have longitudinally grooved cores. The step-by-step movement is given to the type-wheel, and the printing is on the open or closed circuit. The type-wheel is moved around on its shaft the extent of one letter, to bring into position the alternate types that had been out of action. The type-wheels of the various machines are brought to unison by an arm brought into the path of a stop on the type-wheel shaft, or by a wedge on the printing lever and a tooth-wheel on the type-wheel shaft, with one tooth removed to stop the action. The impression is given by the inertia of a weight that is moved with the printing lever. An air-cylinder and piston prevent the printing lever moving except when the circuit is kept closed. The paper is fed by a claw and toggle. The type-wheels have endwise motion on the shaft by an electro-magnet and change of circuit, or by radially slotted wheels and connection to the printing lever. From the sending station the pulsations are given by a rotary pulsator driven by a magnetic motor with a governor. The pulsator is stopped by one of a range of finger-keys, and the circuit closed to the printing magnet.

French Telegraphs.—A correspondent of the *Pall Mall Gazette* writing recently from Paris, says:—"The attention of the public is drawn this morning to the fact of the Government intercepting telegrams despatched to the provincial press, and, by all accounts, the telegraphic censors have been guilty of very sharp practice. The *Journal de Paris* pities the position in which clerks are placed, as they are liable not only to get into trouble for transmitting messages but for not transmitting them. The writer mentions the instance of a head clerk who was removed from Paris to the provinces for the crime of having delayed a despatch to the *Times* for a few hours.

New Submarine Telegraph Cable.—Telegraph cable works have been erected on the Pacific Coast, at San Francisco, and the Electrical Construction Company have completed the first section of their first contract, namely, a cable for the British Columbian Government. It is intended to be submerged under Rosario Straits, to connect Vancouver's Island, at Victoria, with the continent. The cable is 35,000 feet in length, and weighs about 30,000 lbs. The conductor is composed of seven No. 20 copper wires of 97 per cent fineness. The dielectric consists of two coats of pure gutta-percha $\frac{9}{32}$ of an inch in diameter, with intermediate coatings of Chatterton's compound. The gutta-percha coil is served with two coats of machine-banding, well tarred, and covered with a protecting armour of No. 9 galvanised iron wires, laid on spirally. Electrically tested, the resistance of the conductor is eight ohms, or B. A. units, per knot, and the resistance of the dielectric or insulating medium, 443,000,000 ohms per knot. The Company has an order on hand to manufacture another cable 30,000 feet long, for the Puget Sound Telegraph Company, to establish a connection between Seattle and Port Townsend.

"F. R. C. S.," writing to the *Daily News* says:—"Ten days ago, a telegram was received at my house relative to an invalid who, with his brother, was about to come to London. As the telegram appeared to contain two mistakes, the most important of which was the substitution of "mother" for "brother," I had it repeated, trusting to the printed notice, which says that in case an error has been made the amount paid for repetition will be refunded on application to the Secretary. The order for repetition was sent from a local post-office to the head office, in Telegraph Street. From thence it was sent, not to Ranelagh, Co. Dublin, where the message had originated, but to Ranelagh Street, Liverpool, whence a reply was received that they knew nothing of it. A second time the order was sent to Telegraph Street, marked Ranelagh, Dublin, and a second time, I am credibly informed, was it transmitted to Liverpool, whence, of course, the astonished clerks could only reply that they already stated they knew nothing of it. A third effort at making Telegraph Street understand that there was such a place as Ranelagh, Dublin, proved more successful, and procured me a second telegram, stating that the gentleman and his brothers (another error) were coming over; following upon which a third telegram, sent from a different office in Dublin, correctly stated that Mr. A. and his brother would come. On the following day (Nov. 7), I wrote to the Secretary enclosing the three telegrams, and requesting the matter to be investigated, and the money I had paid to be refunded; but, beyond the usual official notification of the receipt of my letter, I have heard nothing more about it."

Societies' Meetings for the Month.

Telegraph Engineers.—Session, 1873. Jan. 8.
Geological Society.—Dec. 18.—Session, 1873. Jan. 8.
Meteorological Society.—Council Meeting, Dec. 18.—Ordinary Meeting, Jan. 15, 1873.

To Correspondents.

⁂ Pressure on our space compels us to postpone our leading article on "International Telegraphy in Time of War." It will appear in our next issue, which will also contain valuable papers on "Telegraphic Batteries," and "Ampère's Theory of Magnetism,"

Resistance.—Your suggestions form part of our proposed plan; but we cannot publish your letter, because it does not bear your name and address. These need not be published, but are required as a guarantee of good faith.

A. Eden.—The point has not been discussed.

H. G. Erichsen, J. Graves, W. Ayrton, and S. E. Phillips are thanked for their communications.